Definition of Physiology

Physiology is the science that seeks to explain the physical and chemical mechanisms that are responsible for the origin, development, and progression of life. Each type of life, from the simplest virus to the largest tree or the complicated human being, has its own functional characteristics. Therefore, the vast field of physiology can be divided into viral physiology, bacterial physiology, cellular physiology, plant physiology, invertebrate physiology, vertebrate physiology, mammalian physiology, human physiology, and many more subdivisions.

Definition of Physiology

Physiology is the study of the normal functions of the body—the study of the body's molecules, cells, and organ systems, and the interrelationships among them. Because the study of medicine is the study of abnormal functions of the body, it is essential to understand normal physiology if one is to understand the mechanisms of disease. For this reason, physiology and other important sciences basic to medicine are introduced early in the veterinary curriculum.

Physiological importance of Proteins

All Physiological Change Is Mediated by Proteins

Protein Function Depends on Protein Shape and Shape Changes

Physiological importance of Proteins

Physiological roles of the proteins can be divided into:

1-Catalysis

Catalysis is the ability to increase greatly the rate of a chemical reaction without altering the equilibrium of the reaction. The majority of biochemical reactions occur at a physiologically useful rate only because of protein catalysts, called *enzymes*. Examples of

Physiological importance of Proteins

Physiological roles of the proteins can be divided into:

2-Reaction Coupling

In *reaction coupling,* two reactions are joined together with the transfer of energy. Energy from a spontaneous reaction (similar to water flowing downhill) is funneled to a nonspontaneous reaction (e.g., sawing wood) so that the sum of the two reactions is spontaneous. That is, the energy liberated by the "downhill" reaction is used to drive the "uphill" reaction. This is the basic function of a

Physiological importance of Proteins

Physiological roles of the proteins can be divided into:

3-Transport

Proteins provide a pathway for the *membrane transport* of most molecules and all ions into and out of the cell. Transport and transport proteins are discussed more fully after a discussion of the lipid bilayer membrane, the major obstacle to transport.

Physiological importance of Proteins

Physiological roles of the proteins can be divided into:

4-Structure

Proteins that form filaments and glue cells to each other and to their environment are responsible for the *structure* and organization of cells and multicellular assemblies (i.e., the tissues and organs

Physiological importance of Proteins

Physiological roles of the proteins can be divided into:

5-Signaling

The cell can send signals, and the function of some proteins is purely informational. That is, all that some proteins transmit and transduce information. Information can be defined as “any difference that makes a difference,” or more simply, any difference that regulates something.

Allostery

The ability of proteins to change shape is called allostery (Greek for "other shape")

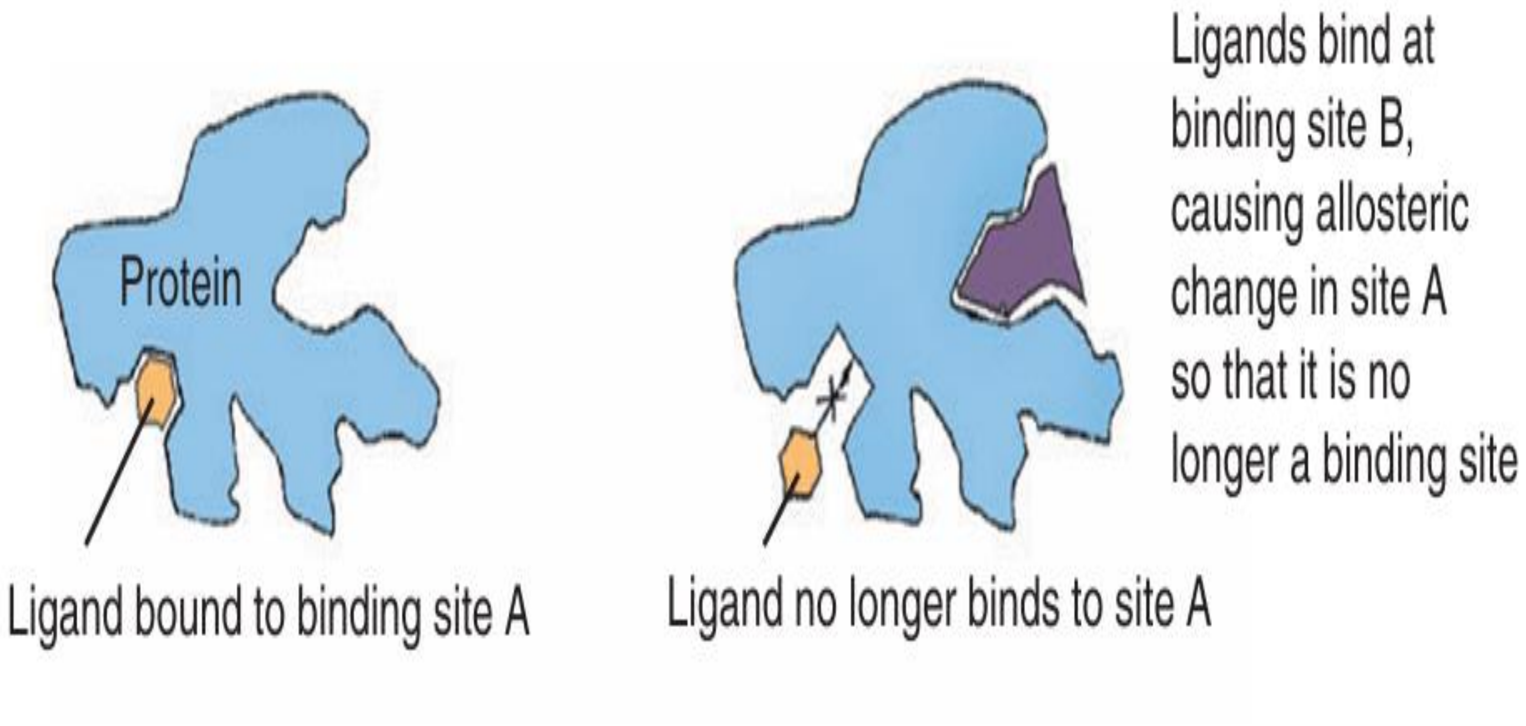
Common mechanisms of allosteric shape change in proteins:

1-Ligand binding

2-Phosphorylation

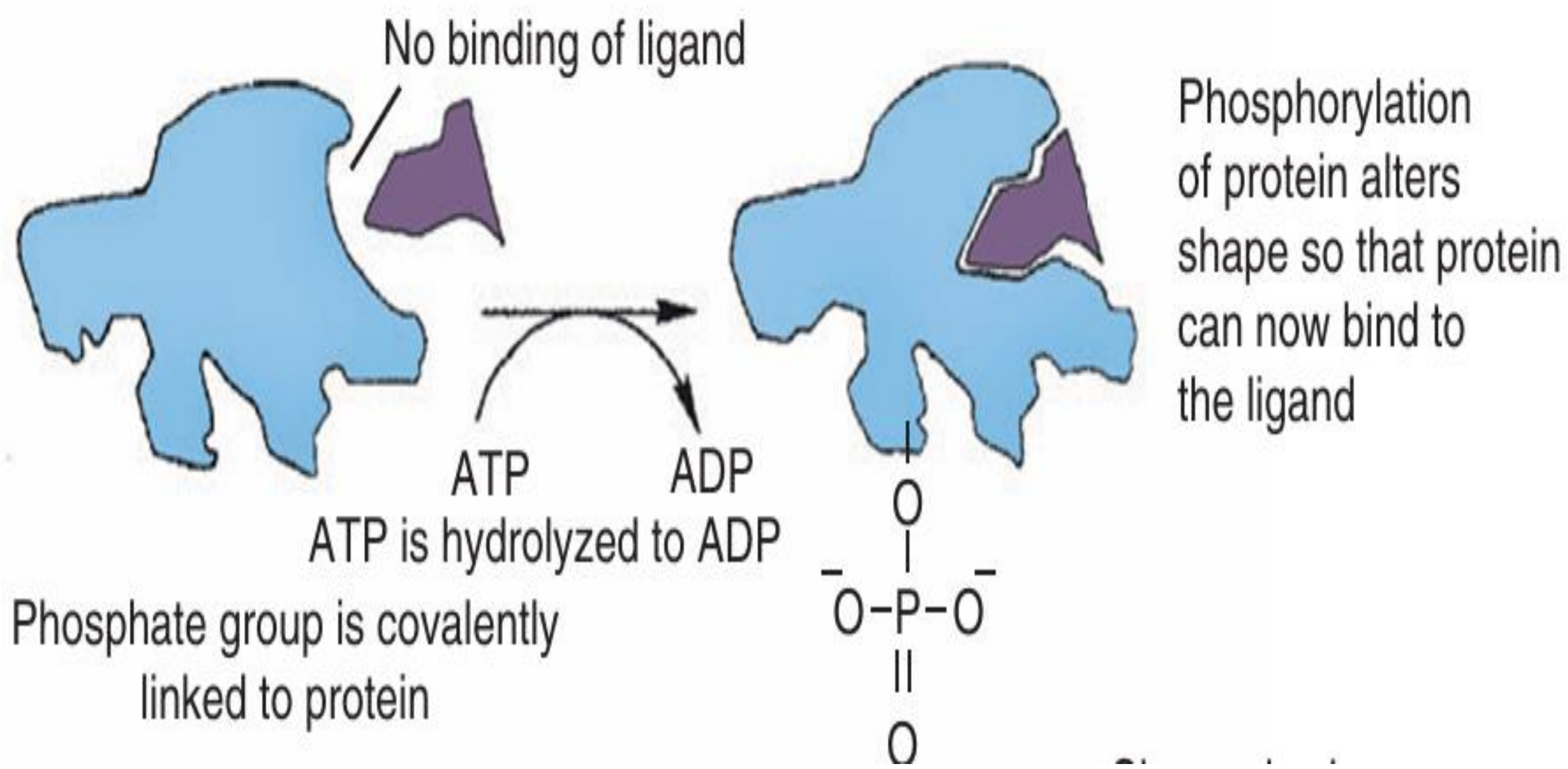
3-Voltage-dependent allosteric shape change

Allostery

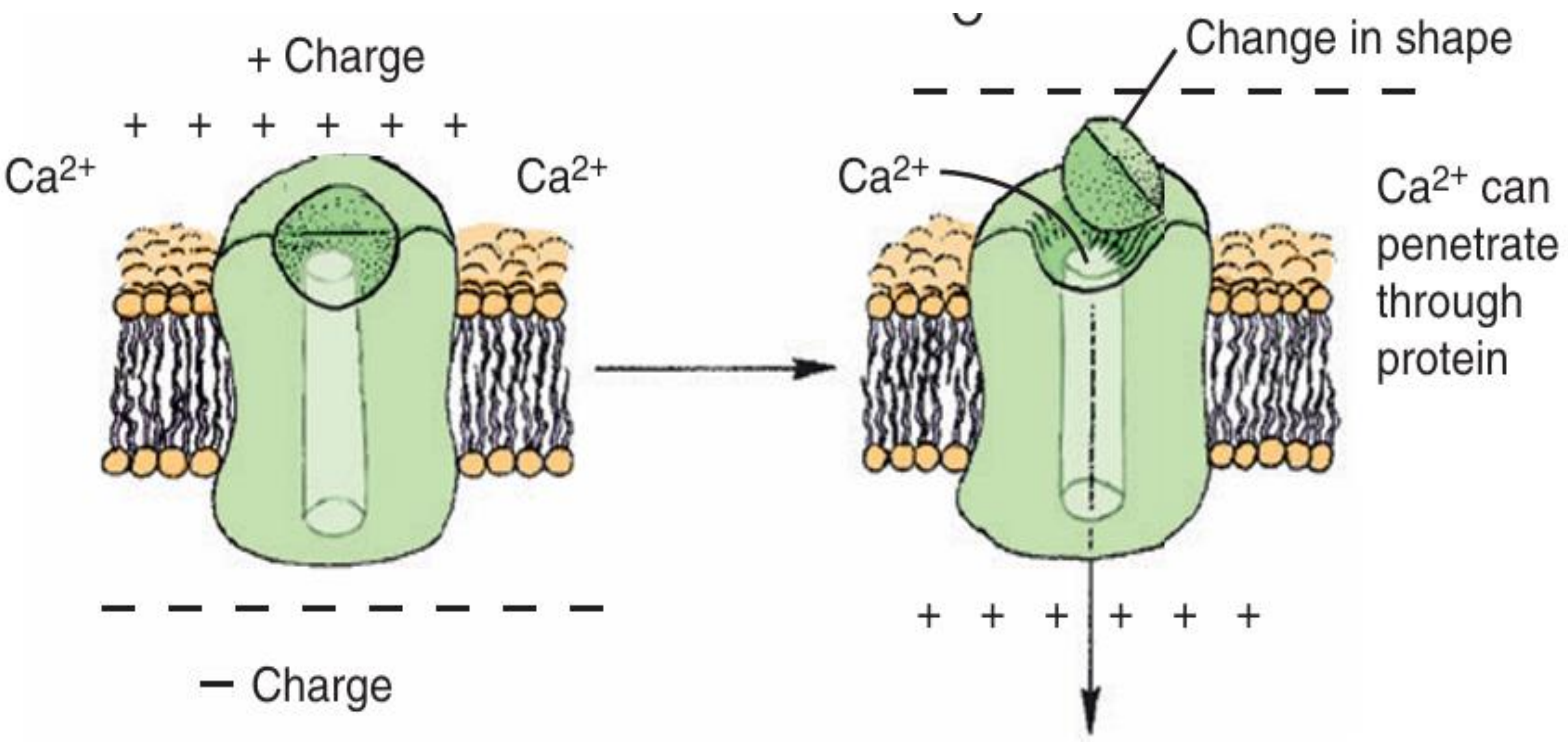


Protein
Ligand bound to binding site A
Ligand no longer binds to site A
Ligands bind at
binding site B,
causing allosteric
change in site A
so that it is no
longer a binding site

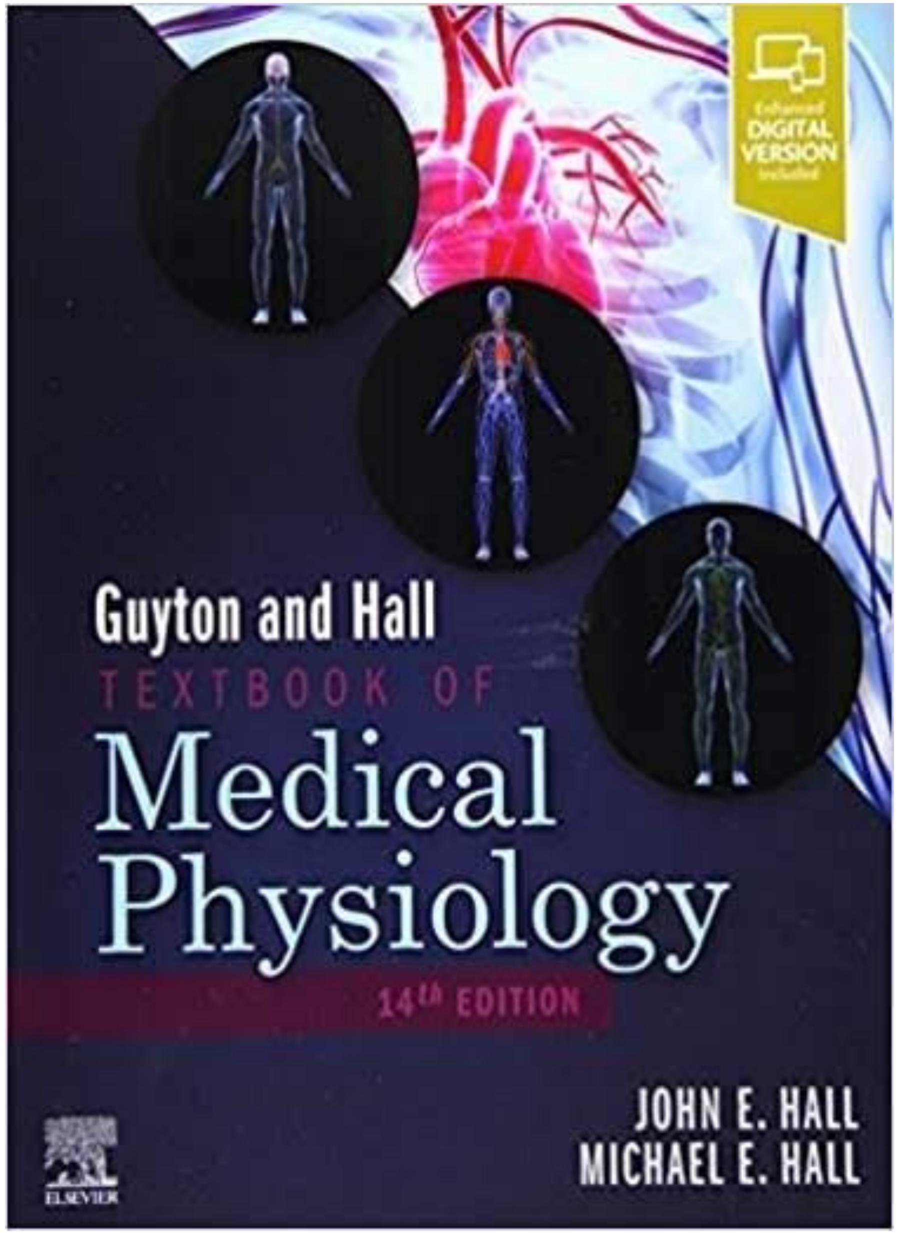
Allostery

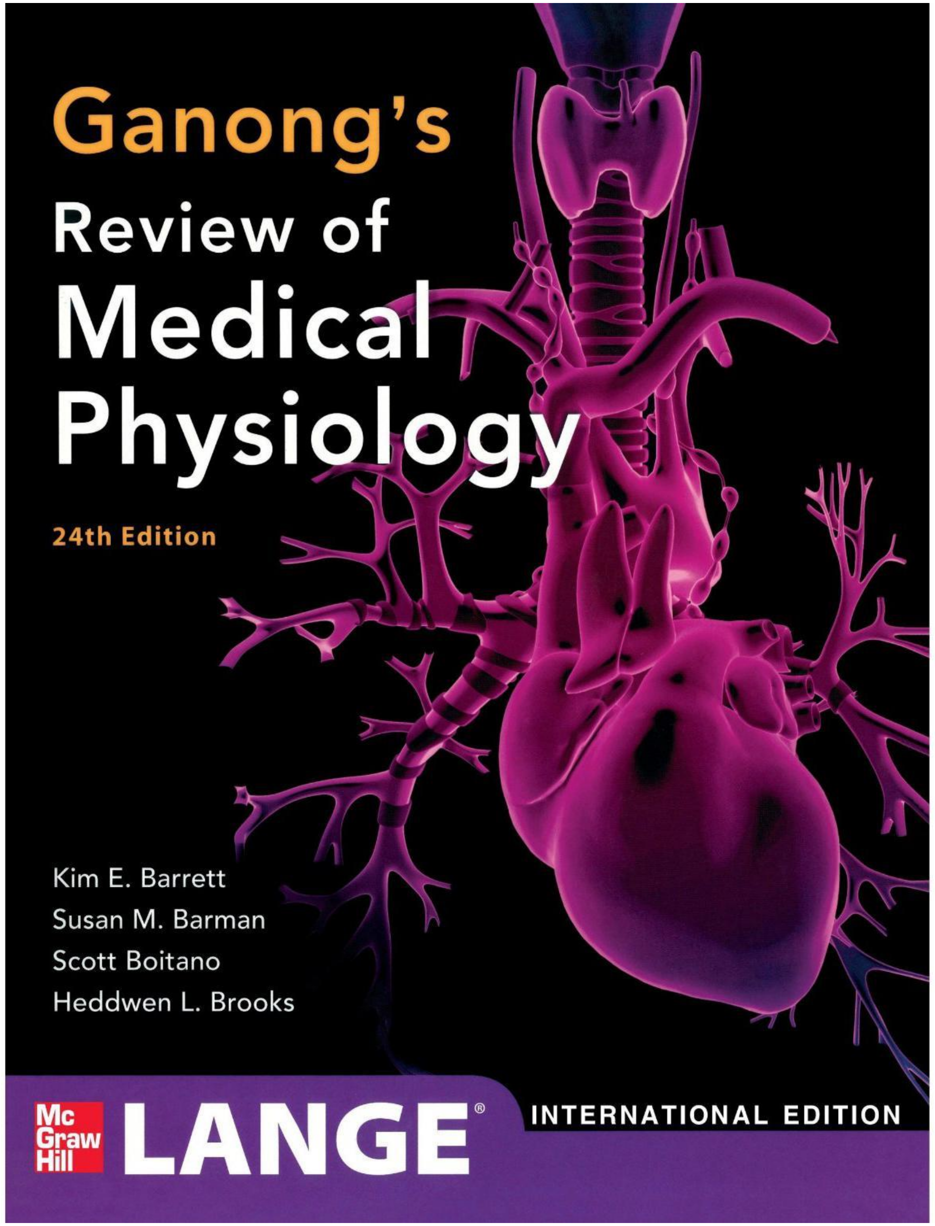

No binding of ligand
Phosphorylation
of protein alters
shape so that protein
can now bind to
the ligand
ATP
ADP
ATP is hydrolyzed to ADP
Phosphate group is covalently
linked to protein
O
O-P-O
O

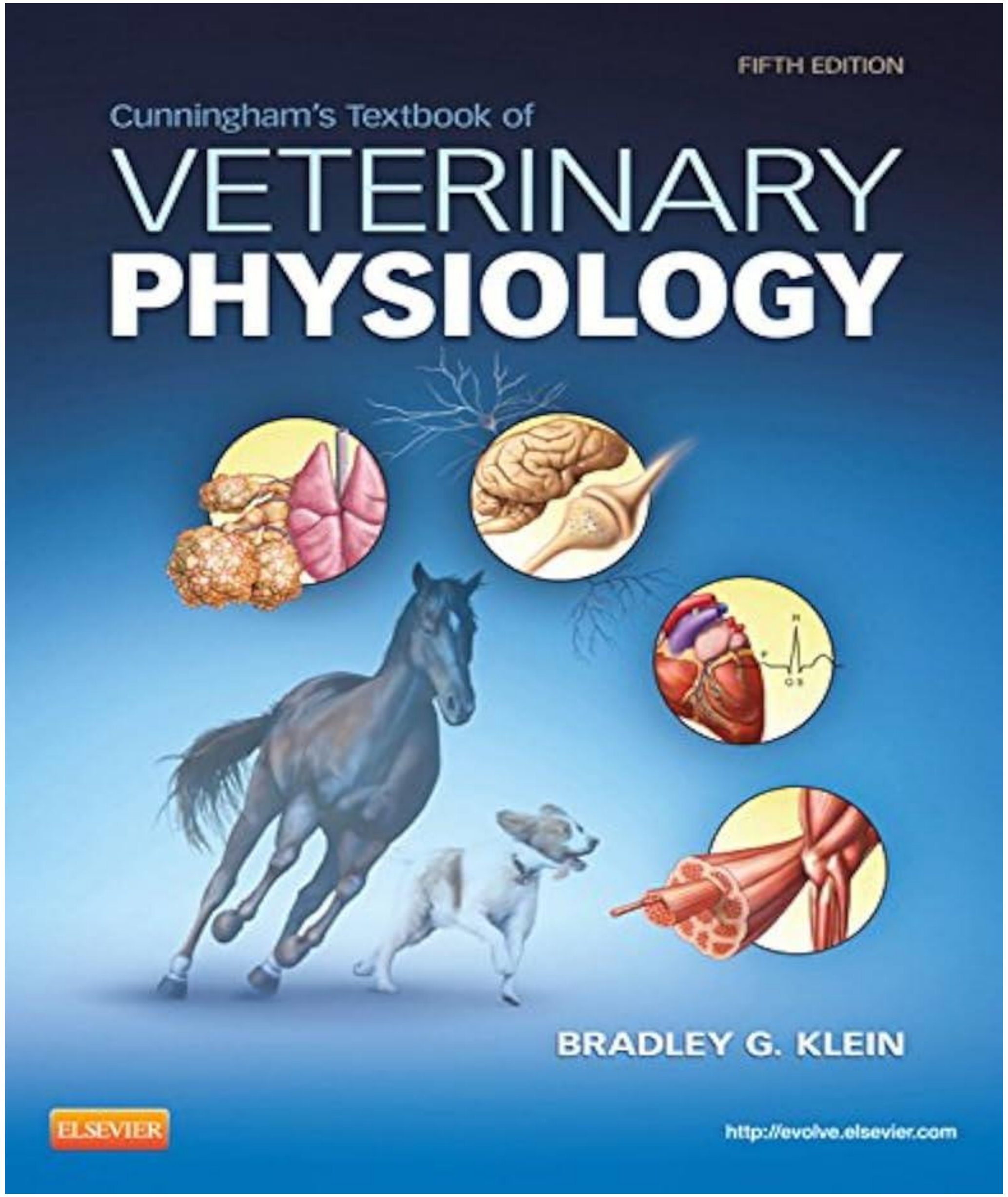
Allostery

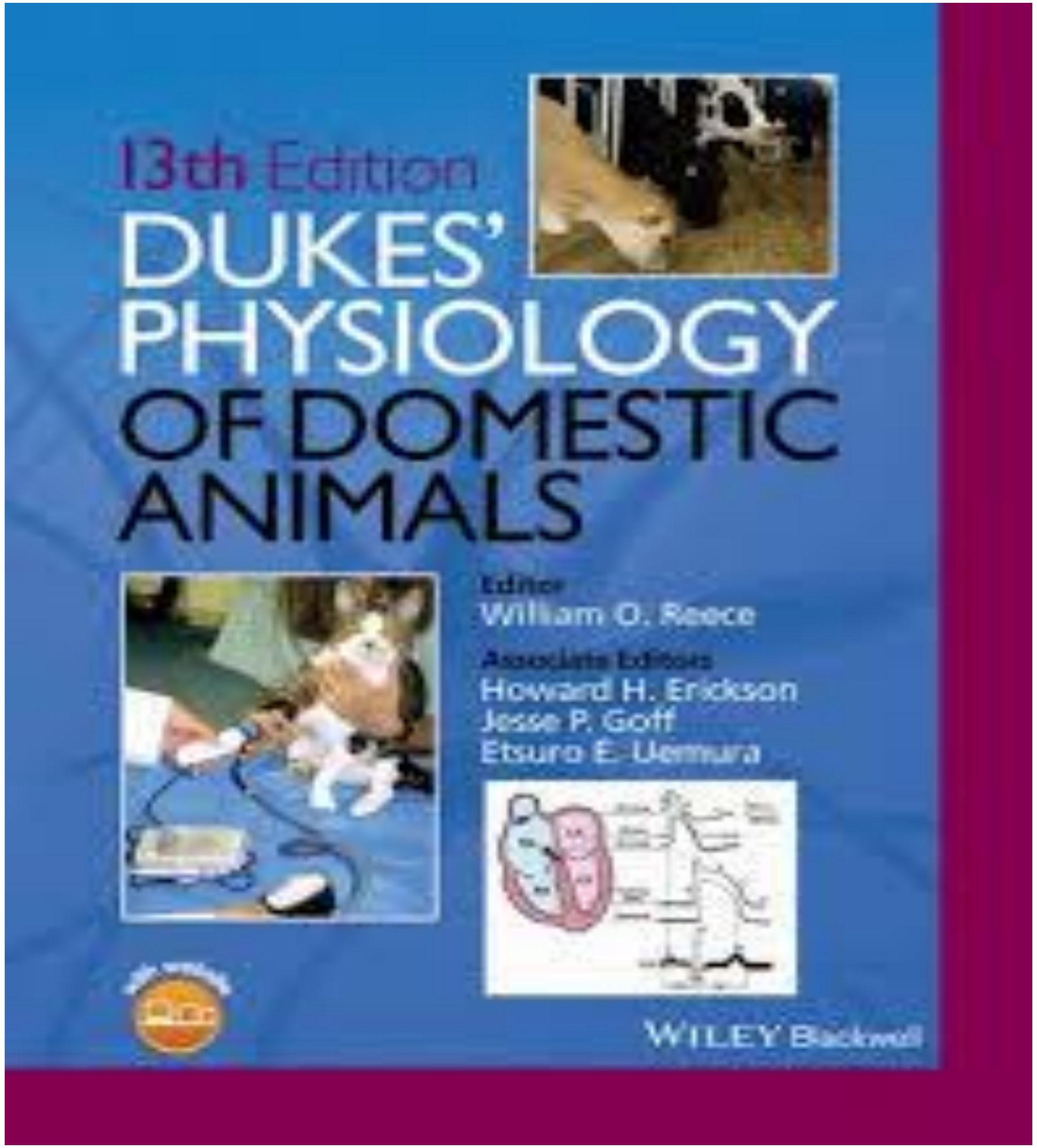


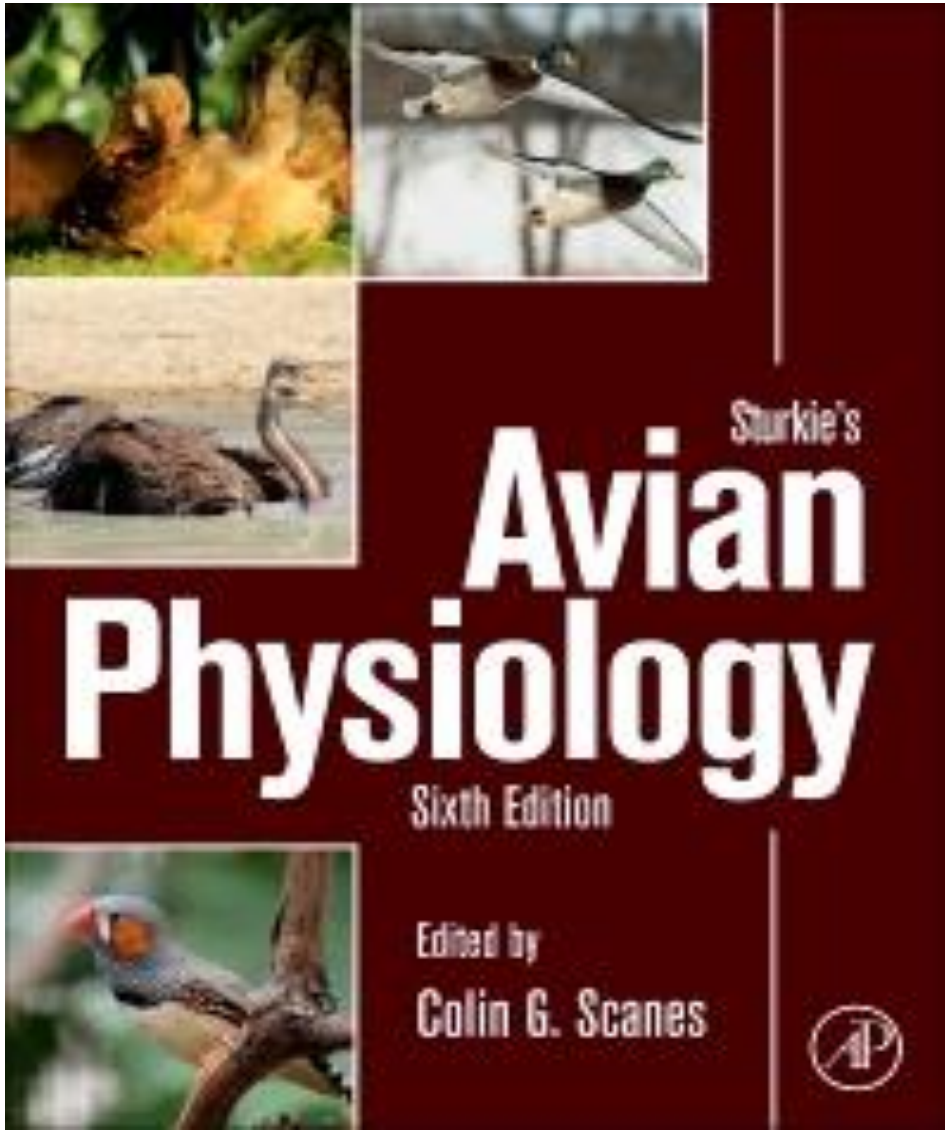
+ Charge
Ca2+
Ca2+
− Charge
Change in shape
Ca2+
Ca2+ can penetrate through protein

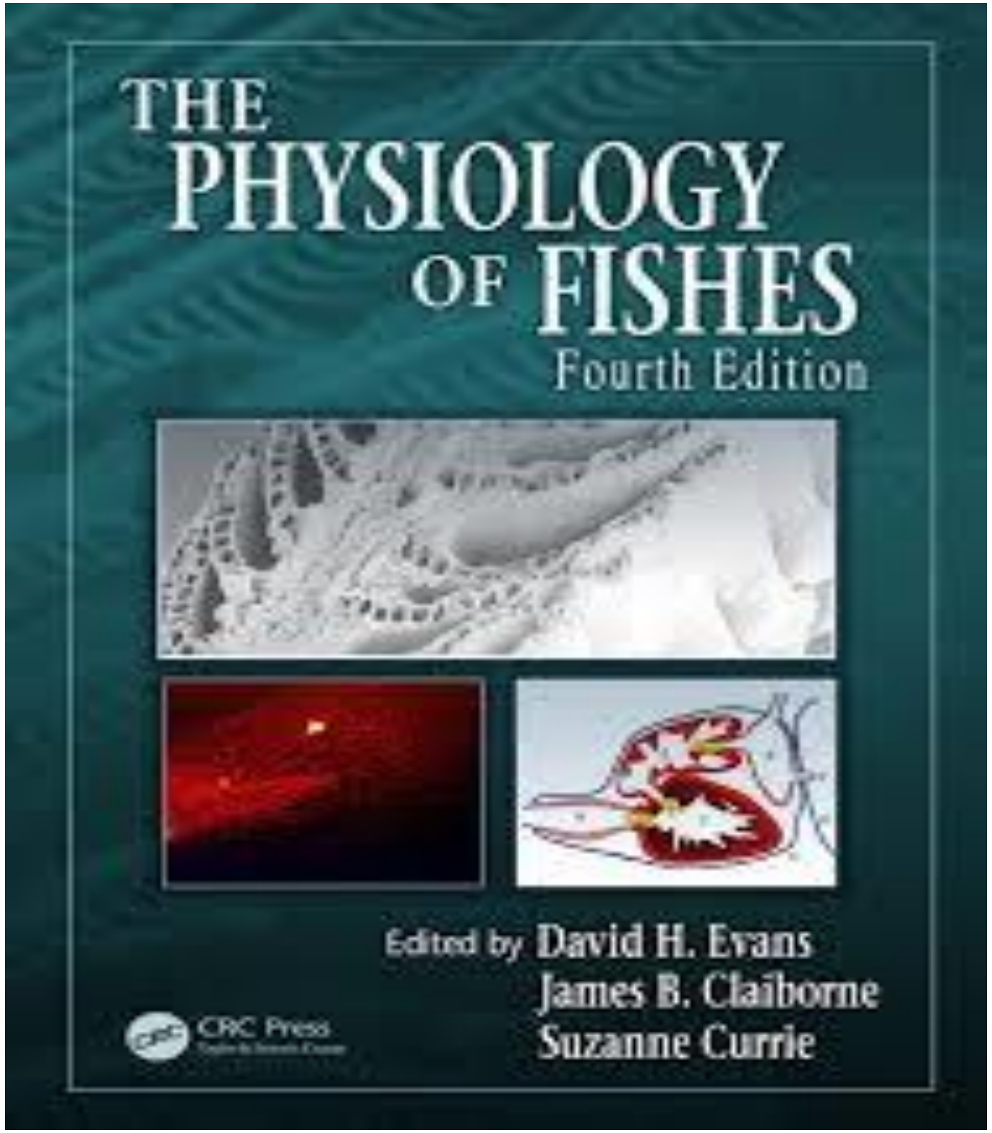

Enhanced DIGITAL VERSION Included
Guyton and Hall
TEXTBOOK OF
Medical
Physiology
14th EDITION
JOHN E. HALL
MICHAEL E. HALL
ELSEVIER


Ganong's
Review of
Medical
Physiology
24th Edition
Kim E. Barrett
Susan M. Barman
Scott Boitano
Heddwen L. Brooks
Mc Graw Hill
LANGE®
INTERNATIONAL EDITION


FIFTH EDITION
Cunningham's Textbook of
VETERINARY
PHYSIOLOGY
BRADLEY G. KLEIN
ELSEVIER
http://evolve.elsevier.com


13th Edition
DUKES'
PHYSIOLOGY
OF DOMESTIC
ANIMALS
Editor
William O. Reece
Associate Editors
Howard H. Erickson
Jesse P. Goff
Etsuro E. Uemura
WILEY Blackwell


Sturkie's
Avian
Physiology
Sixth Edition
Edited by
Colin G. Scanes


THE
PHYSIOLOGY
OF FISHES
Fourth Edition
Edited by David H. Evans
James B. Claiborne
Suzanne Currie
CRC Press

Body Fluids

Extracellular Fluid(ECF)

Intravascular(Plasma), Interstitial(Tissue),Transcellular Fluids

Intracellular Fluid(ICF)

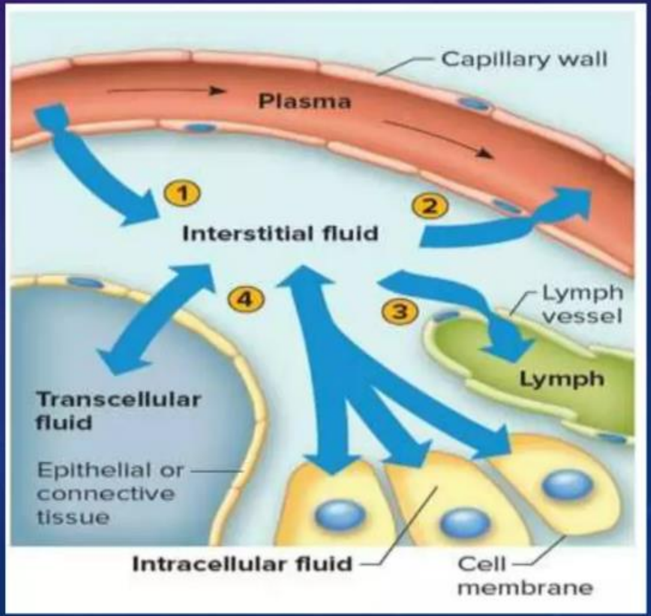
Body Fluids

TABLE 1.1 Concentrations of Various Substances in the Intracellular, Extracellular, and Plasma Fluids

	CONCENTRATION (MMOL/L)		
	Intracellular	Extracellular	Blood Plasma
Na^{+}	15	140	142
K^{+}	150	5	4
Ca^{2+}	0.0001	1	2.5
Mg^{2+}	12	1.5	1.5
Cl^{-}	10	110	103
HCO_3^{-}	10	30	27
Phosphate	40	2	1
Glucose	1	5.6	5.6
Protein	4.0	0.2	2.5

TRANSCELLULAR FLUID

- Fluid produced by the secretory activity of the lining epithelium of potential spaces of the body and is separated from plasma by a bilayer membrane consisting of a capillary endothelium & lining epithelium
- **TCF includes**
  - **CSF**
  - **Synovial fluid (150 ml)**
  - **Fluid of potential spaces**
    - **Pleural**
    - **Peritoneal**
    - **Pericardial**
  - **Fluid of eye**



Internal Environment

In the extracellular fluid are the ions and nutrients needed by the cells to maintain life. Thus, all cells live in essentially the same environment—the extracellular fluid. For this reason, the extracellular fluid is also called the *internal environment* of the body, or the *milieu intérieur*, a term introduced by the great 19th-century French physiologist Claude Bernard (1813–1878).

Homeostasis

In 1929, the American physiologist Walter Cannon (1871–1945) coined the term *homeostasis* to describe the *maintenance of nearly constant conditions in the internal environment*. Essentially, all organs and tissues of the body perform functions that help maintain these relatively constant conditions. For example, the lungs provide oxygen to the extracellular fluid to replenish the oxygen used by the cells, the kidneys maintain constant ion concentrations, and the gastrointestinal system provides nutrients while eliminating waste from the body.

Regulation of body functions

Nervous System

Sensory input, Integrative, Motor output portions

Endocrine(Hormone) System

Homeostatic control mechanisms

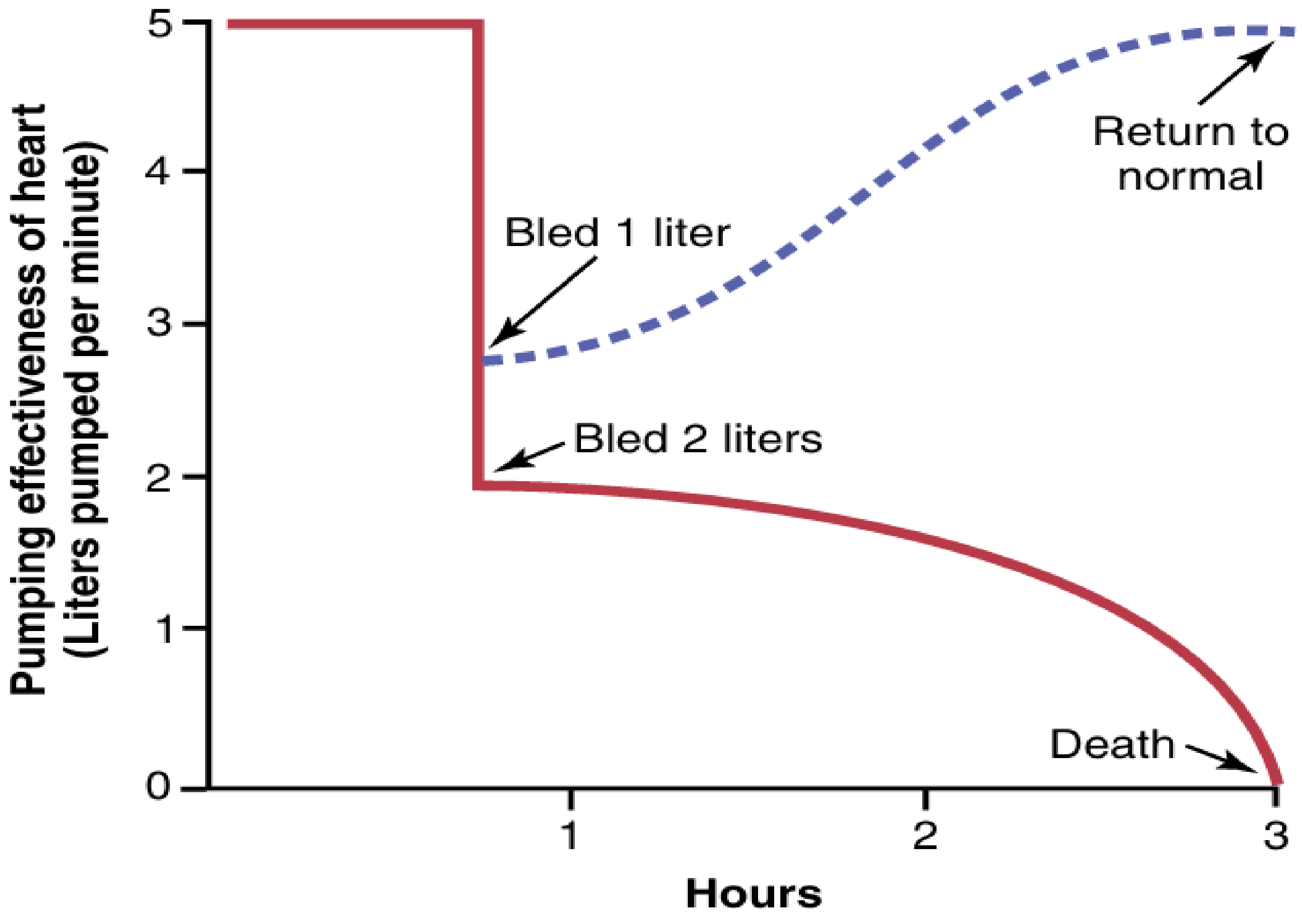
Feedback controls

Negative Feedback Nature of Most Control Systems

Positive Feedback May Cause Vicious Cycles and Death

More Complex Types of Control Systems—Feed-Forward and Adaptive Control

Negative Feedback vs Positive Feedback



Positive feedback can sometimes be useful

Blood clotting

Parturition

Generation of nerve signals

Gain of a control system

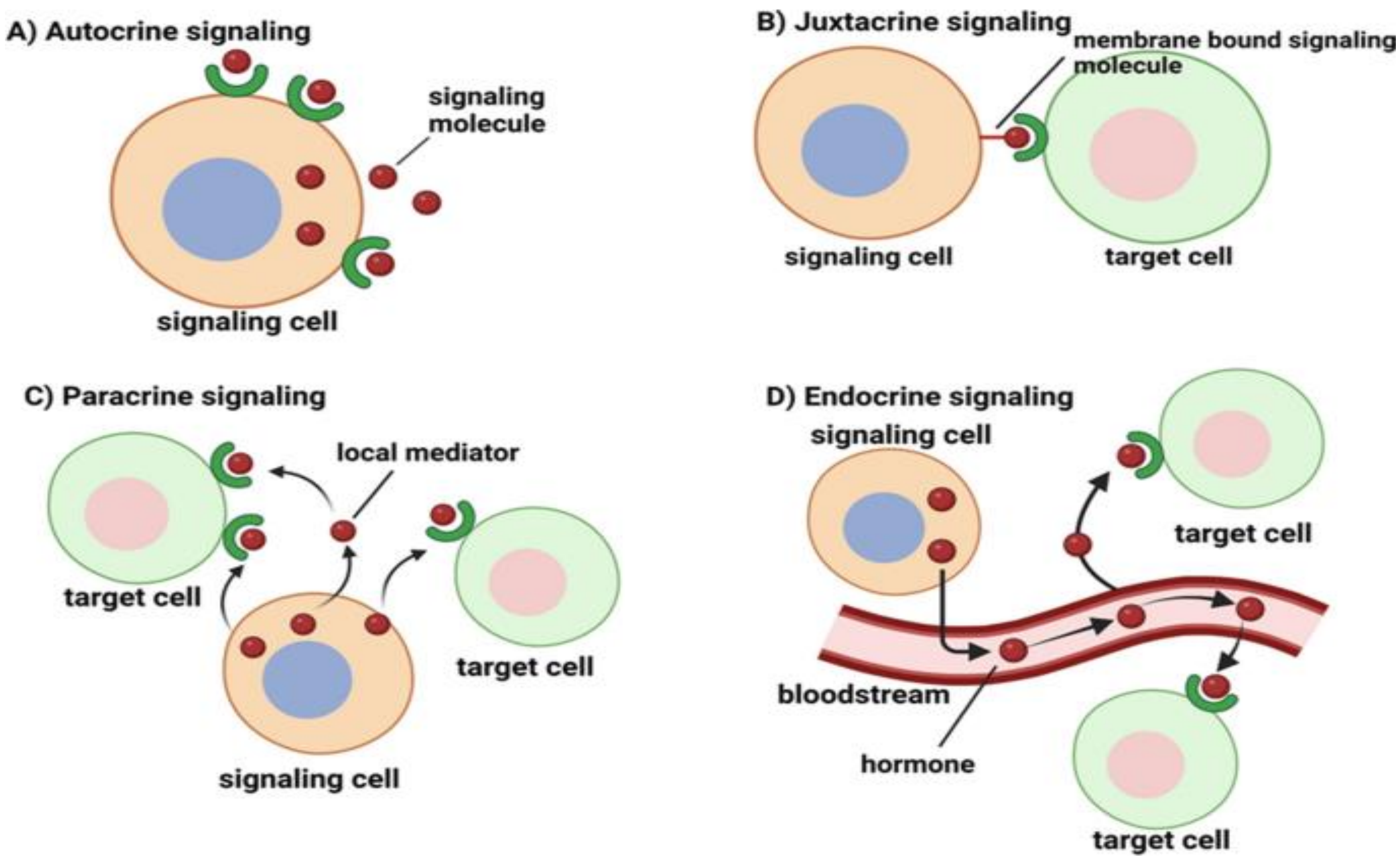
Gain =Correction / Error

Gain of control system

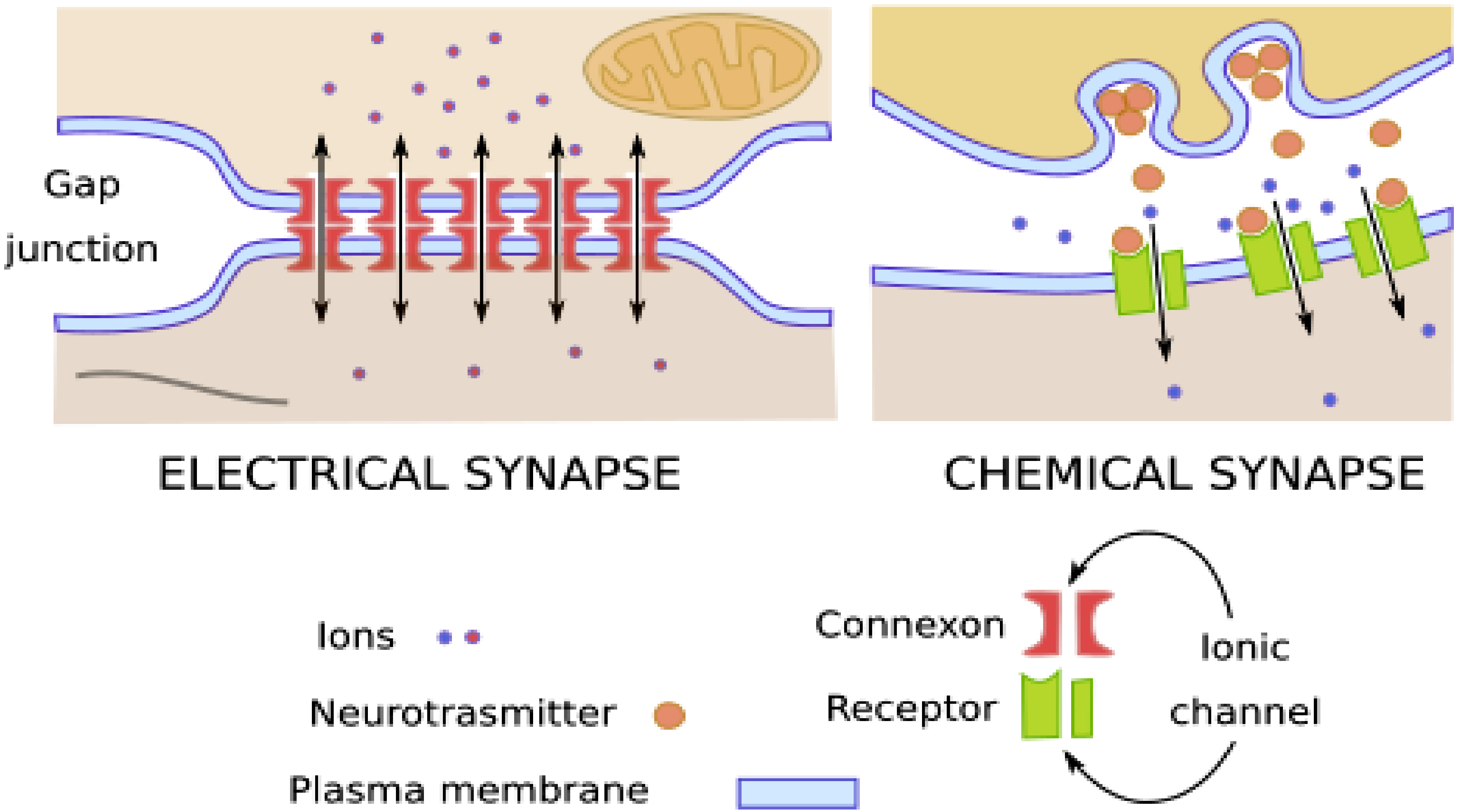
- The degree of effectiveness with which a control system maintains constant condition is determined by the gain of negative feed back
- The control system is not 100 % efficient
- Some error always remain ,

Gain is only applicable in negative feedback mechanism

Cell to Cell Signaling

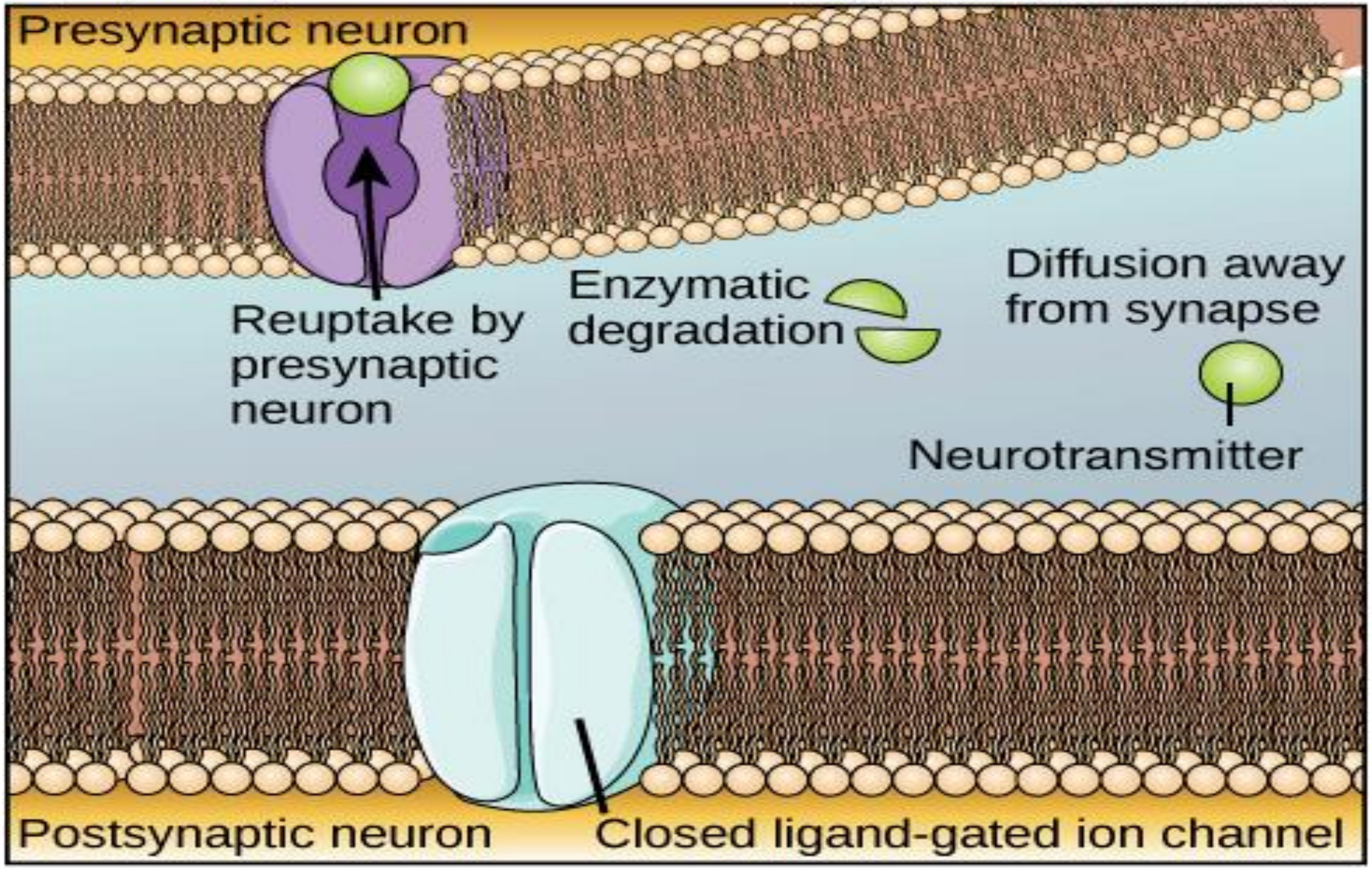


Cell to Cell Signaling

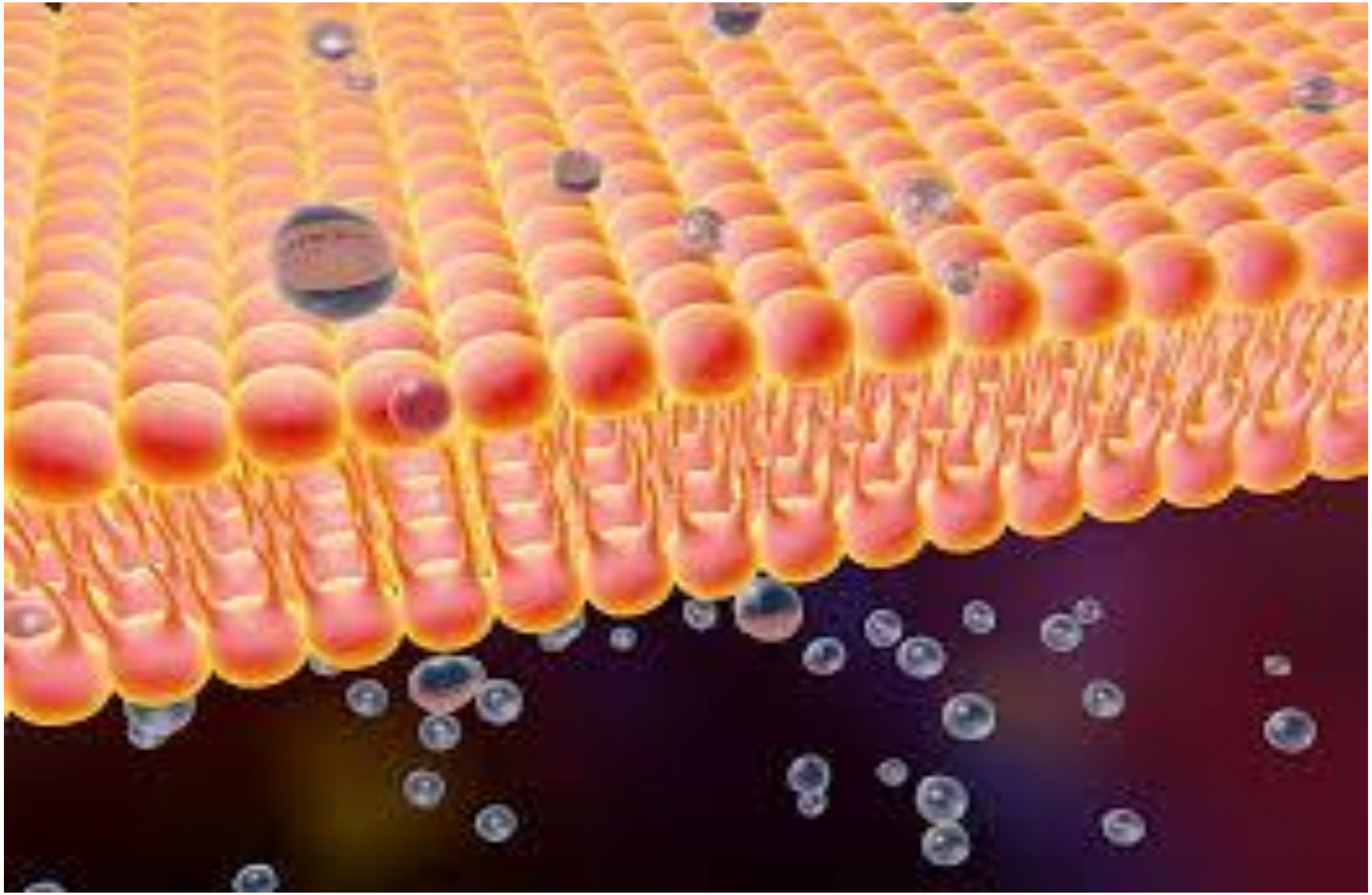


Presynaptic & Postsynaptic Cells

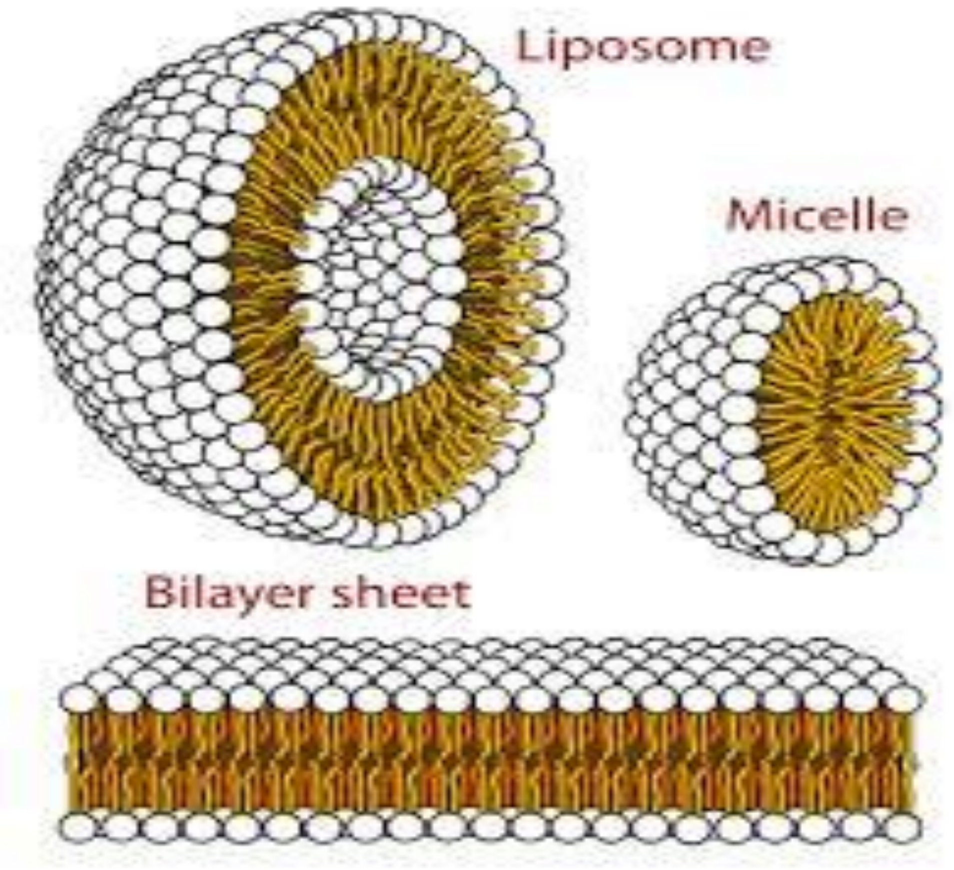
Synaptic transmission & Some Regulatory Mechanisms

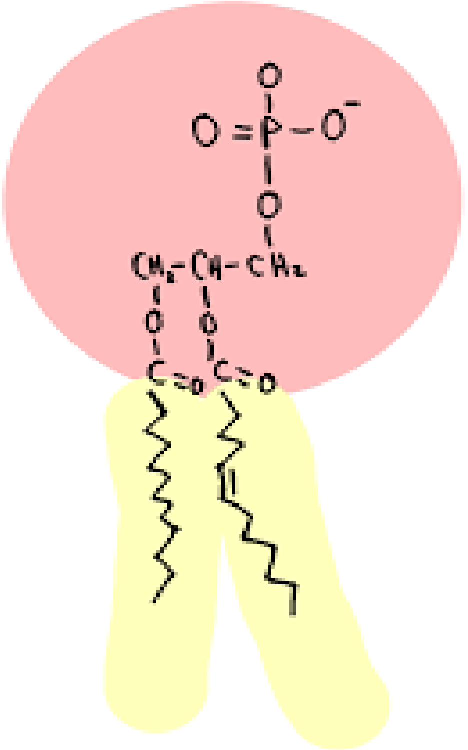


Physiology of Cell(Plasma) Membrane

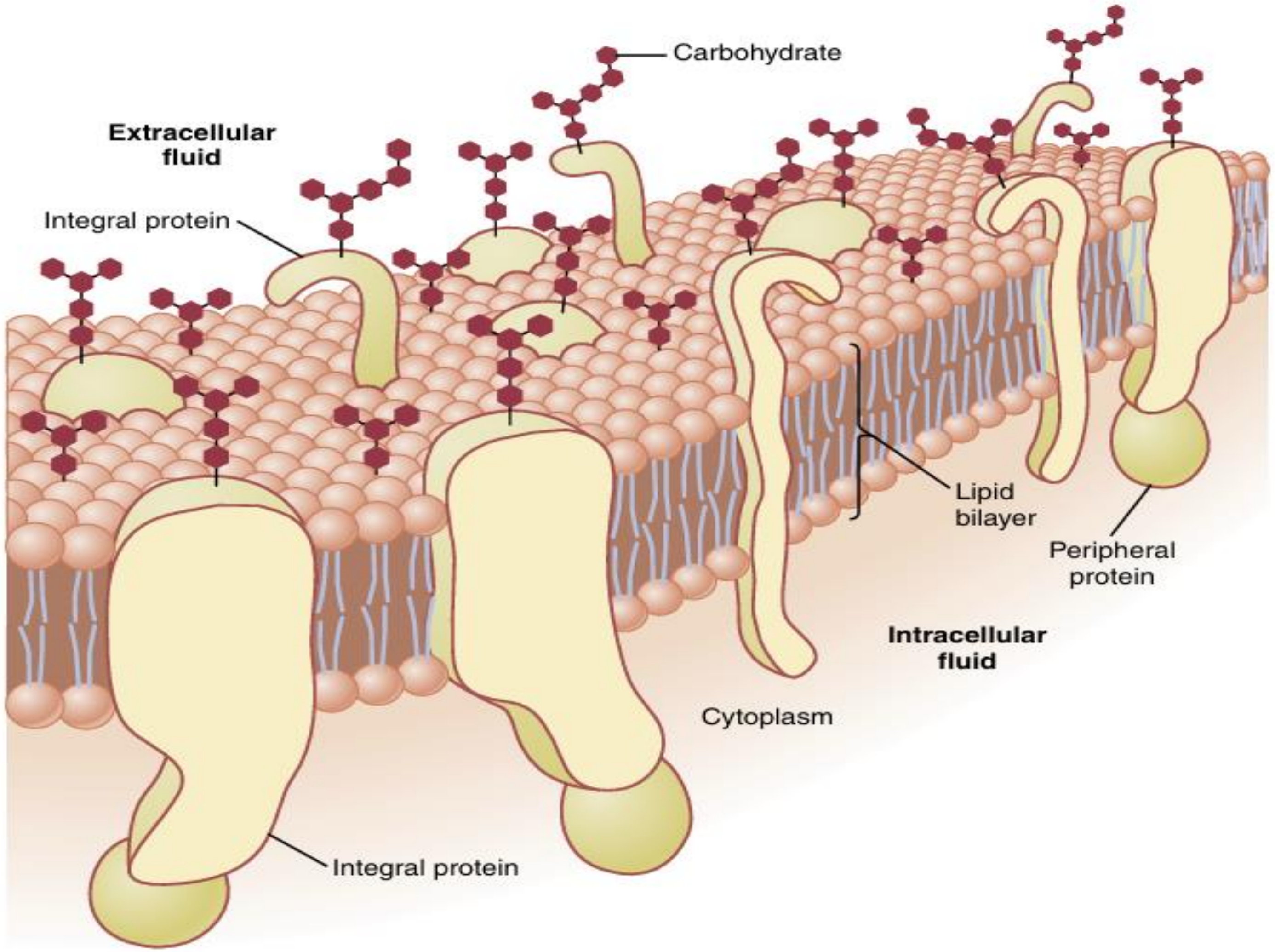


Physiology of Cell(Plasma) Membrane

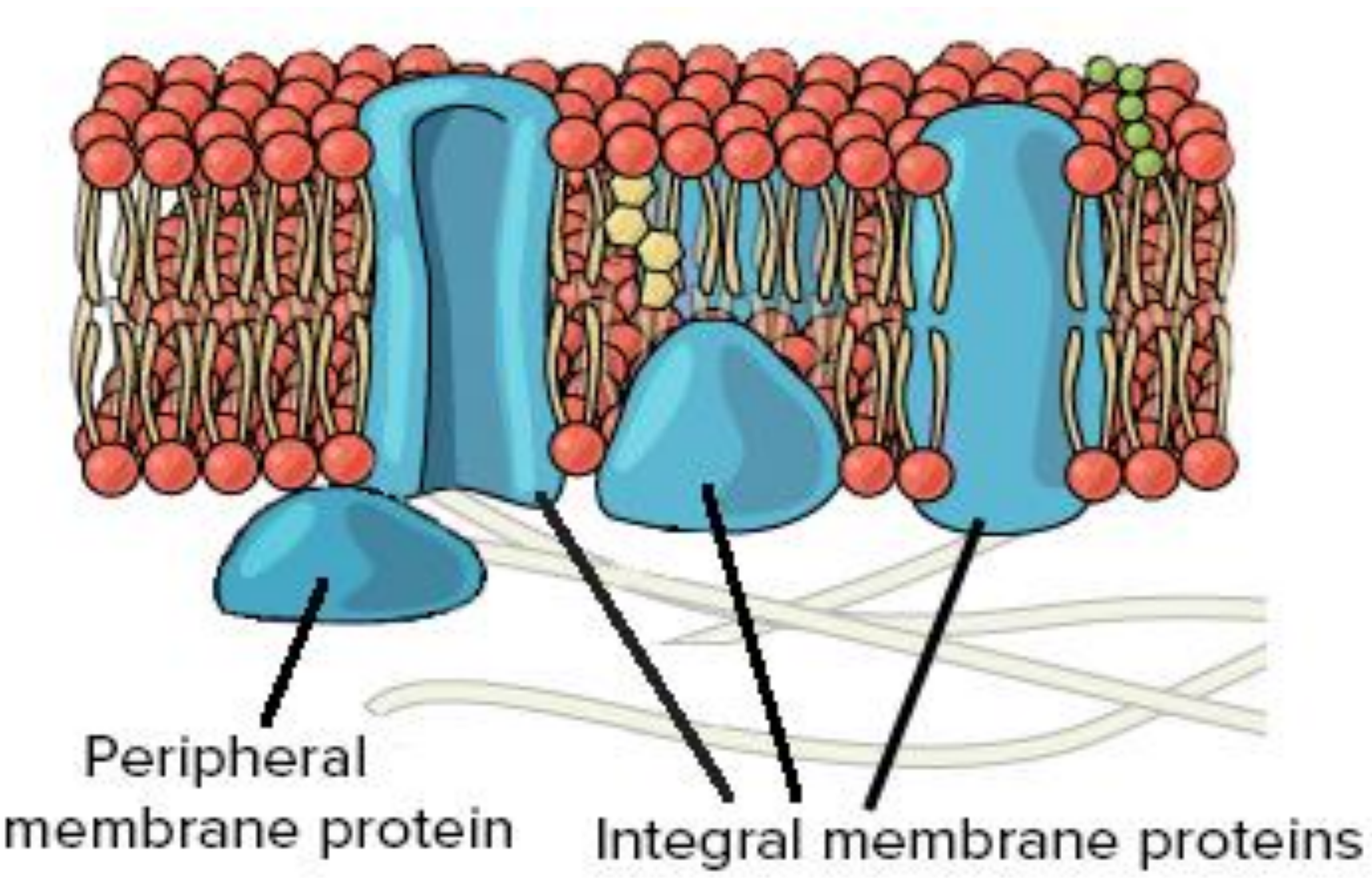




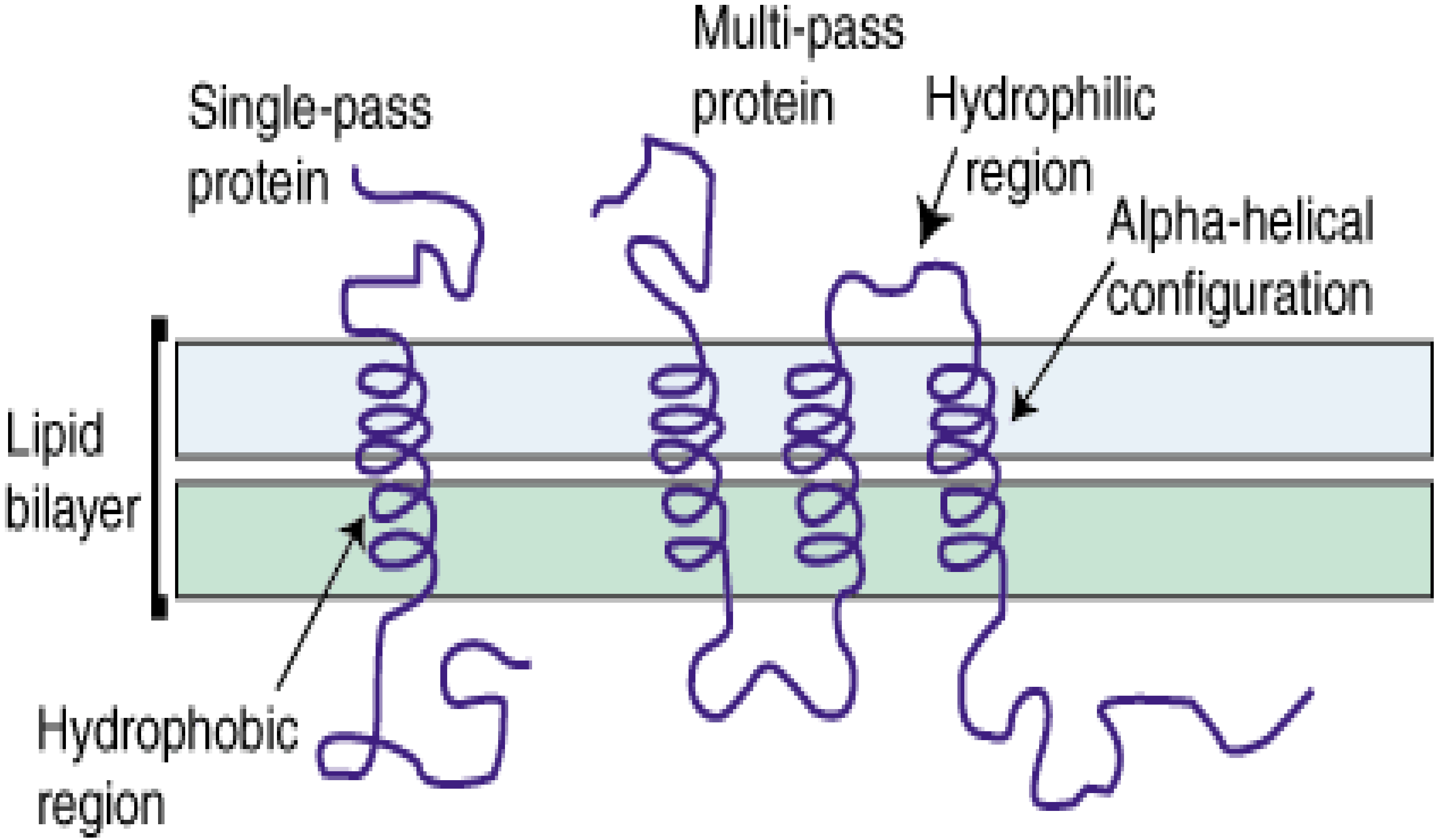
Physiology of Cell(Plasma) Membrane



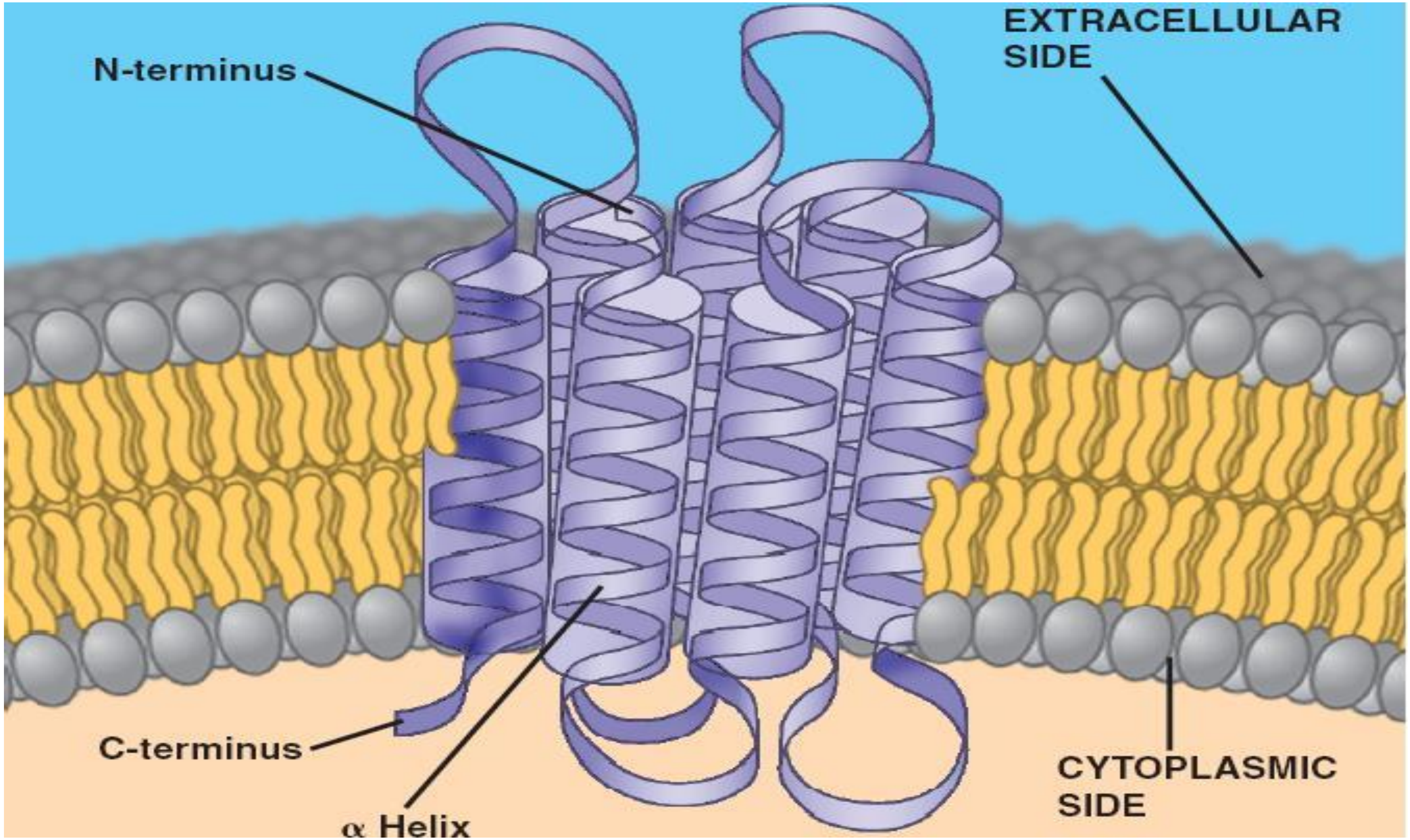
Physiology of Cell(Plasma) Membrane



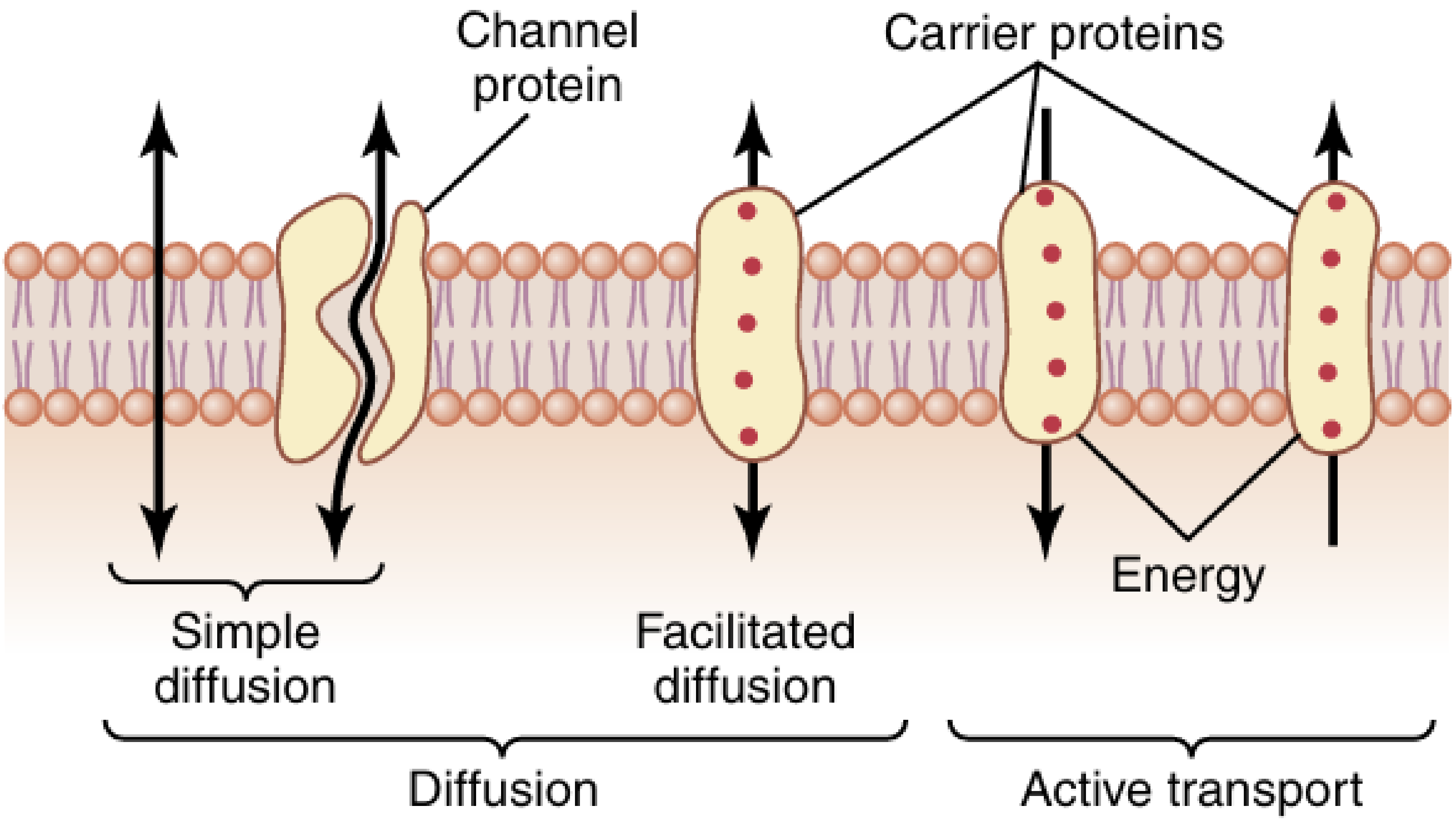
Physiology of Cell(Plasma) Membrane



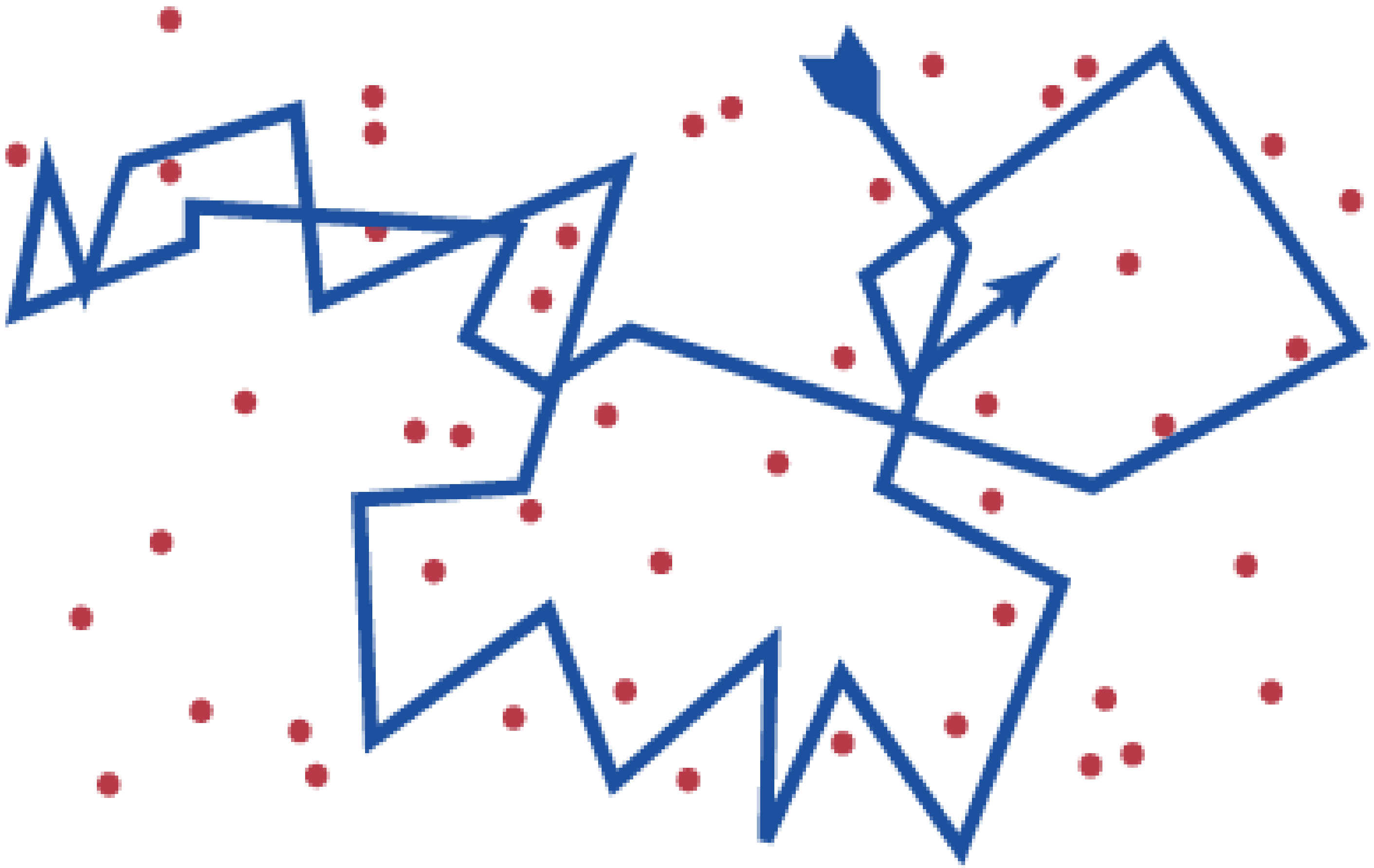
Physiology of Cell(Plasma) Membrane



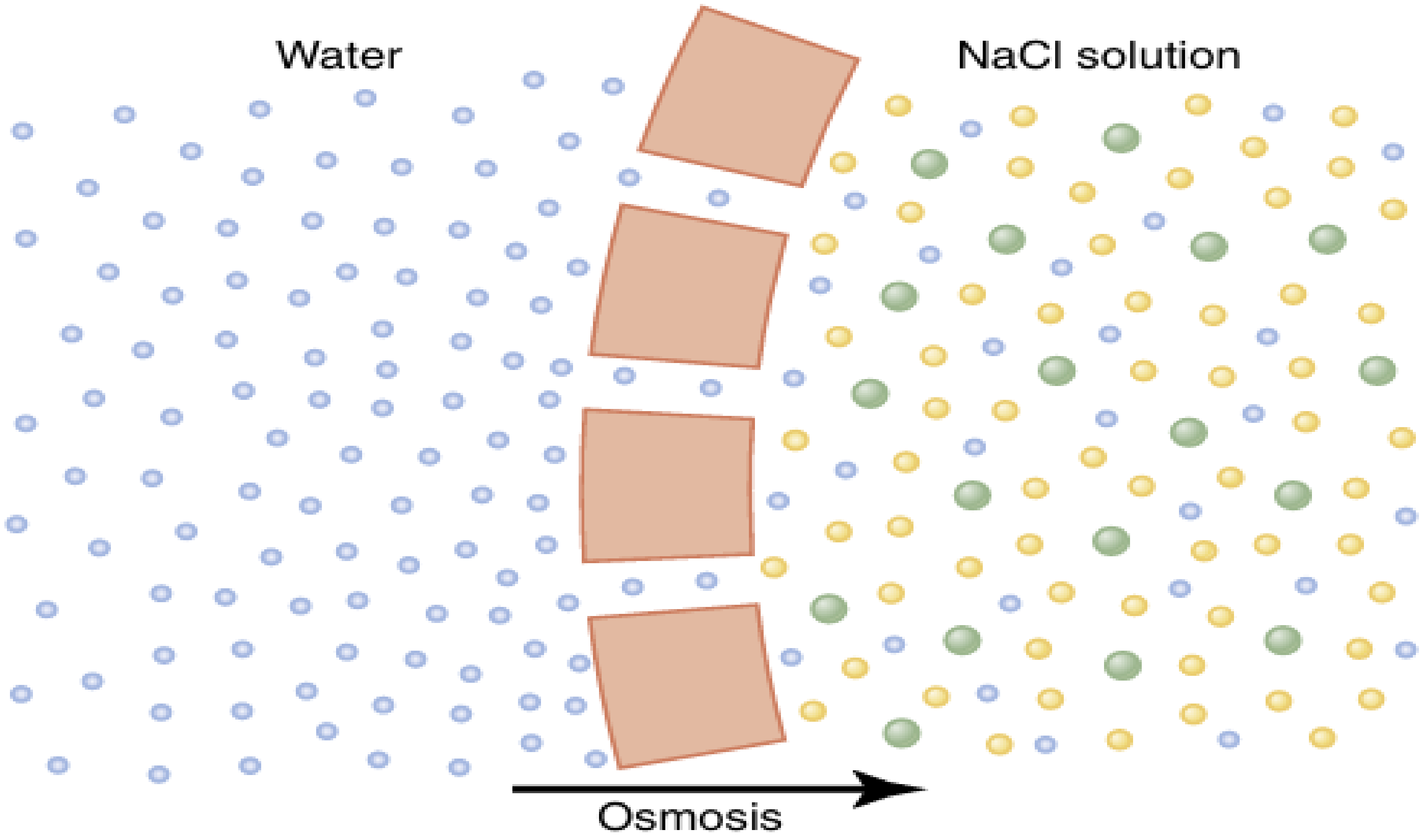
Physiology of Cell(Plasma) Membrane



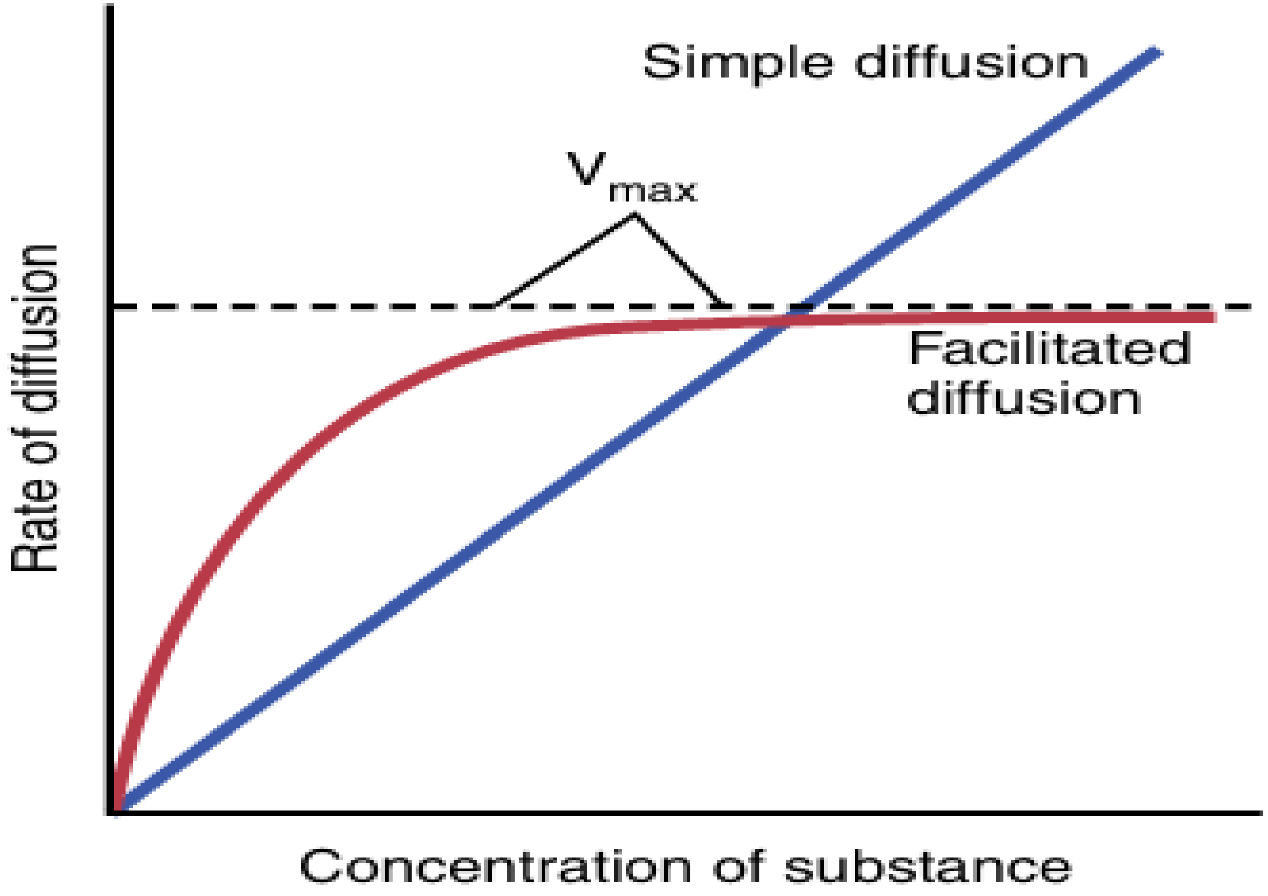
Physiology of Cell(Plasma) Membrane



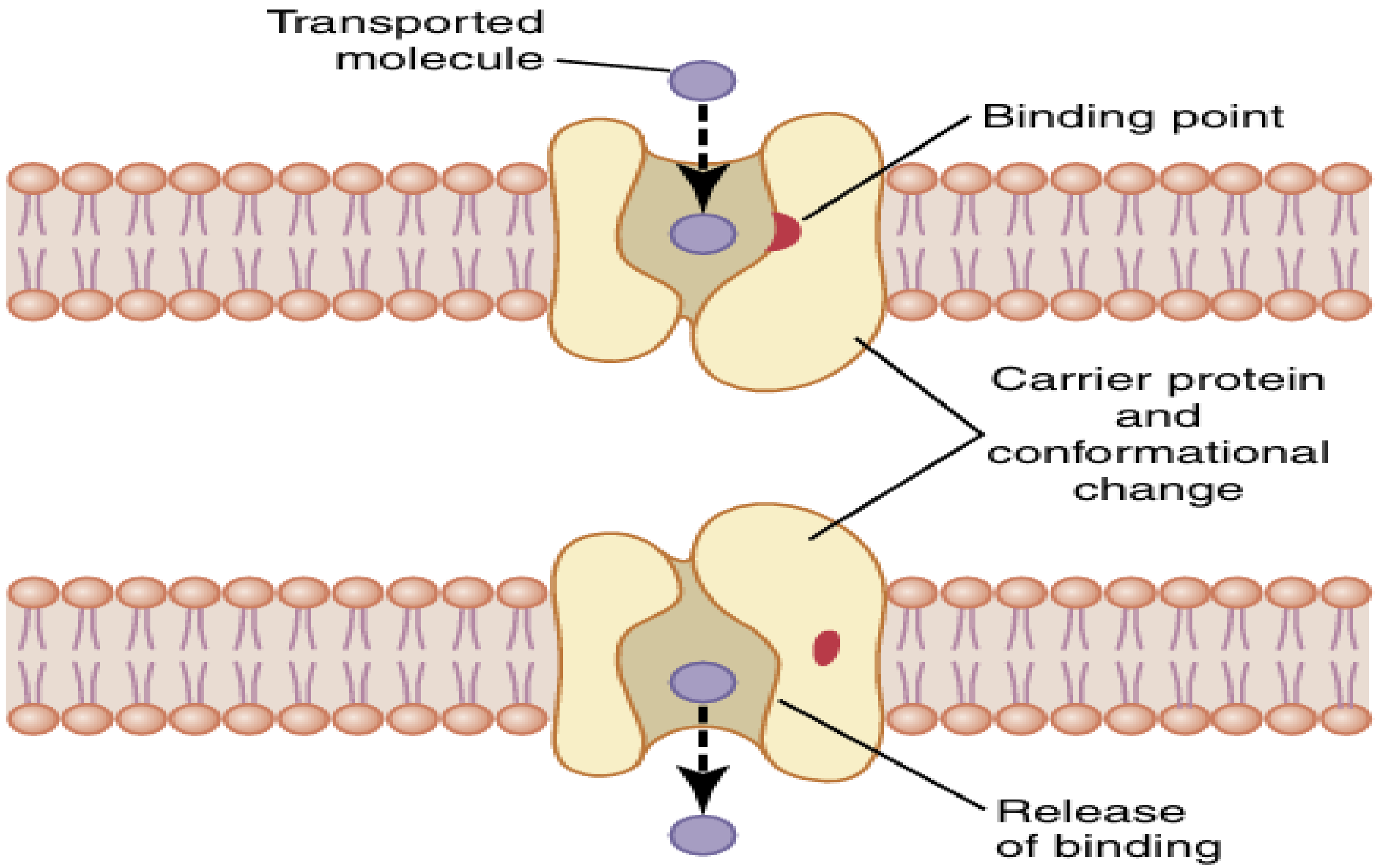
Physiology of Cell(Plasma) Membrane



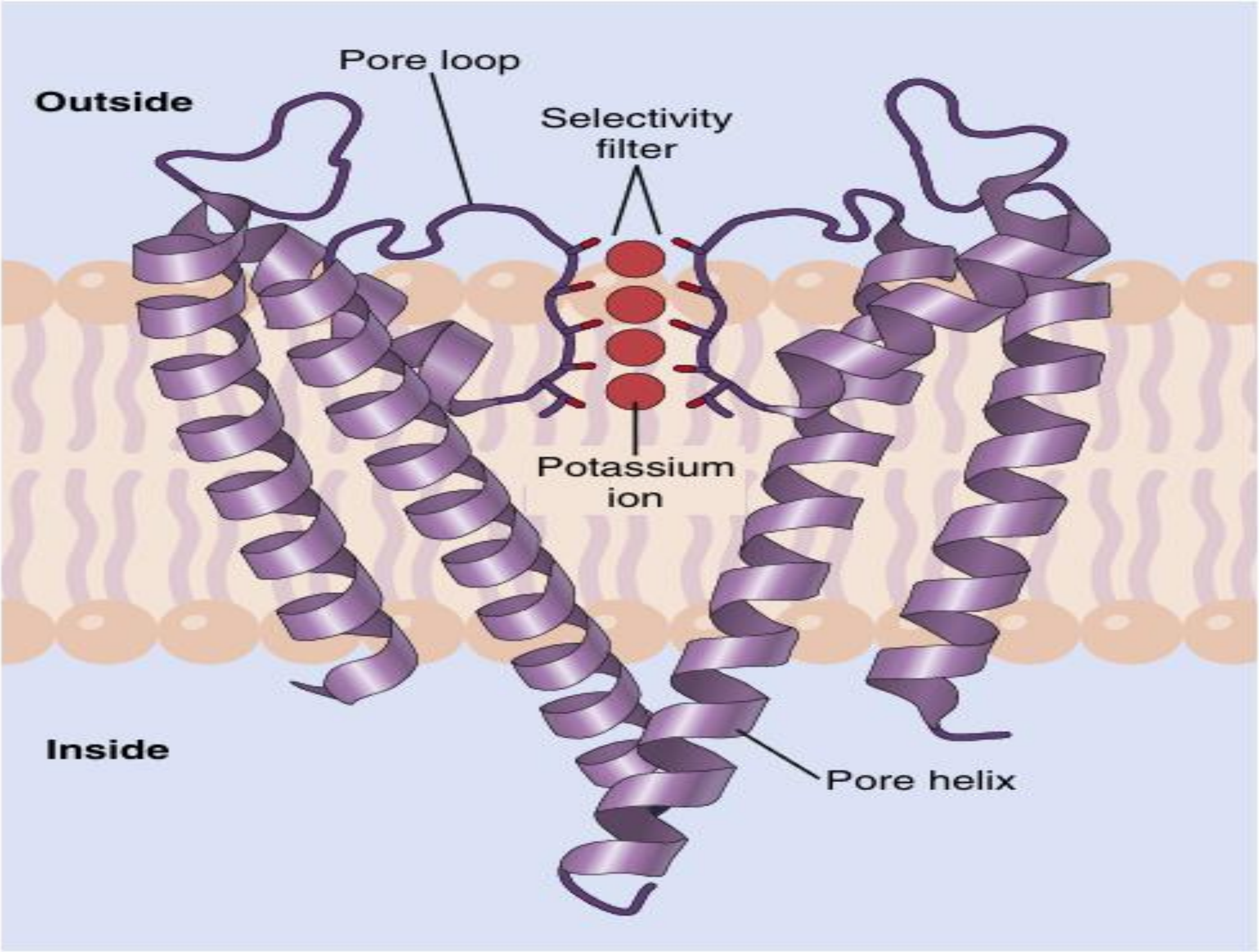
Physiology of Cell(Plasma) Membrane



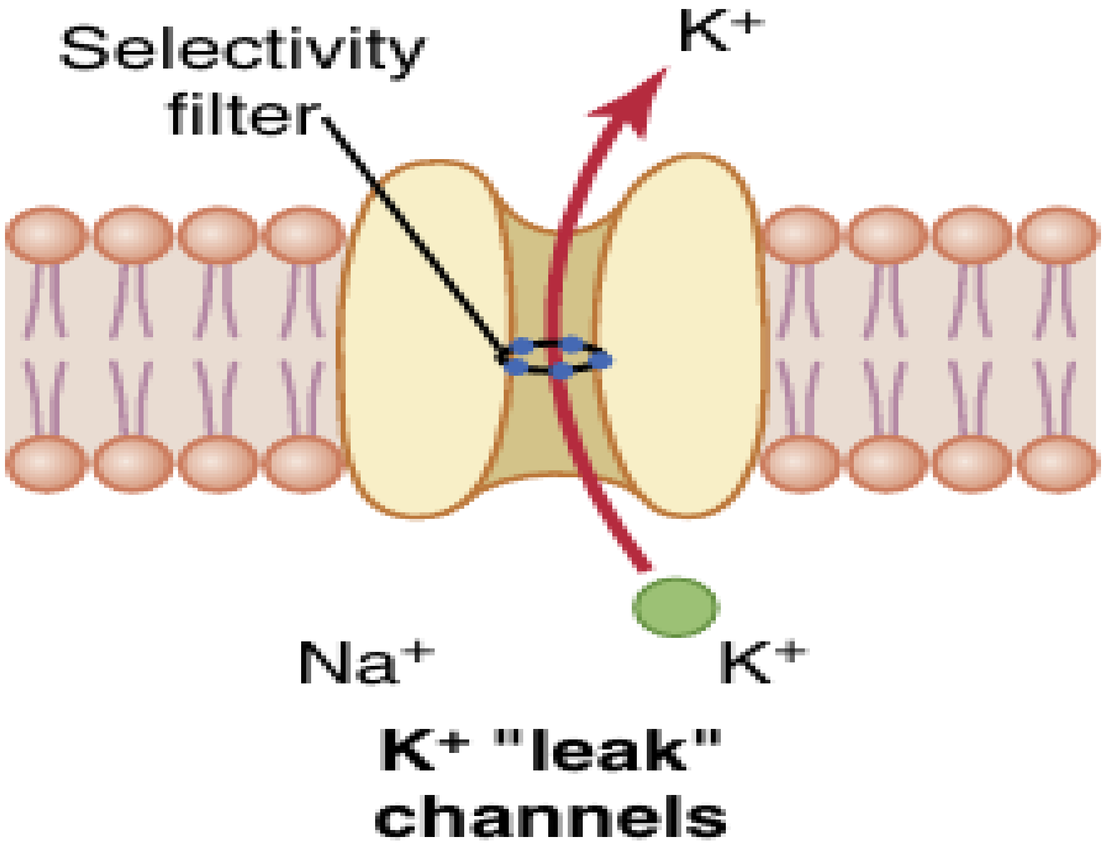
Physiology of Cell(Plasma) Membrane



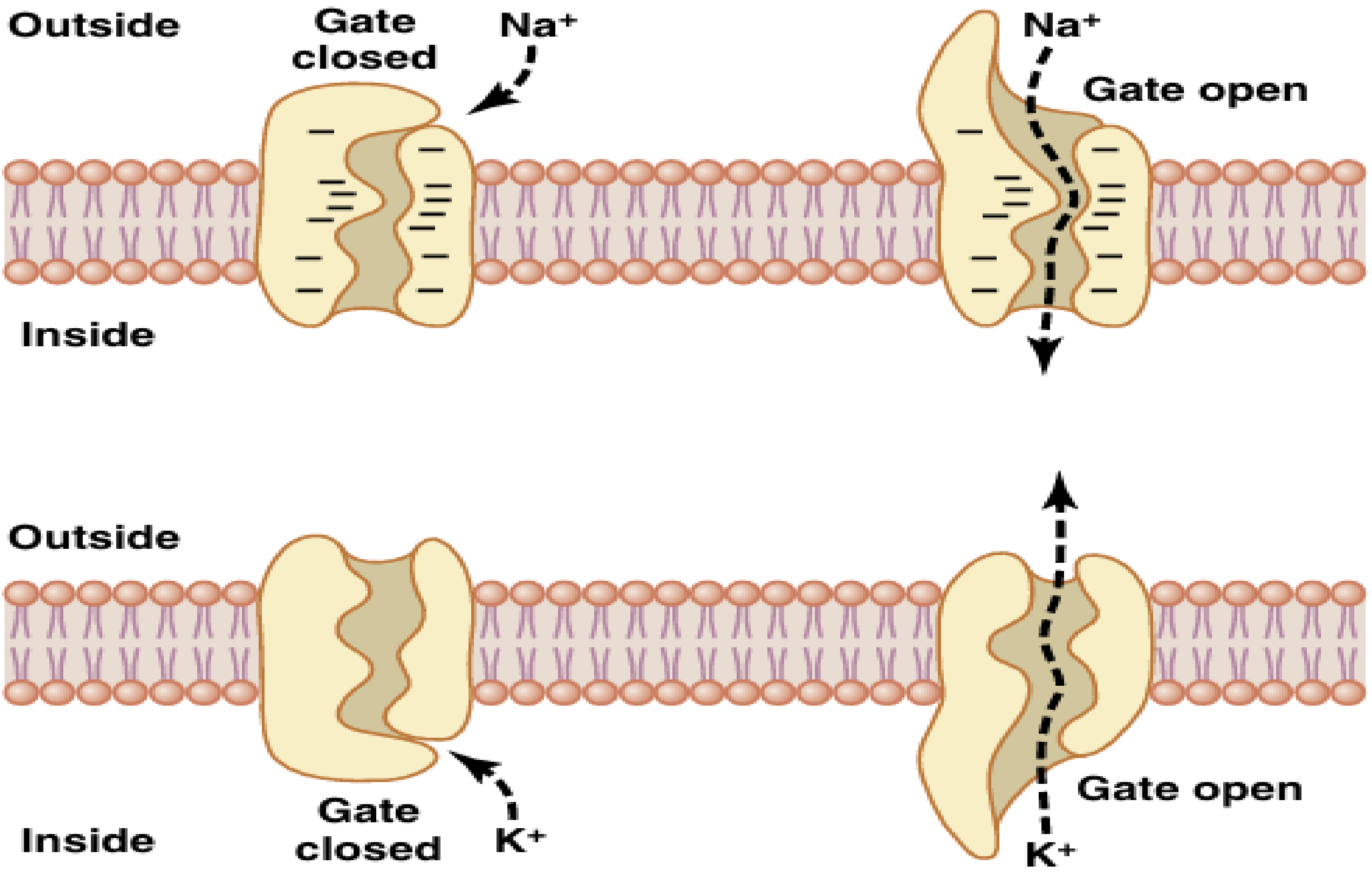
Physiology of Cell(Plasma) Membrane



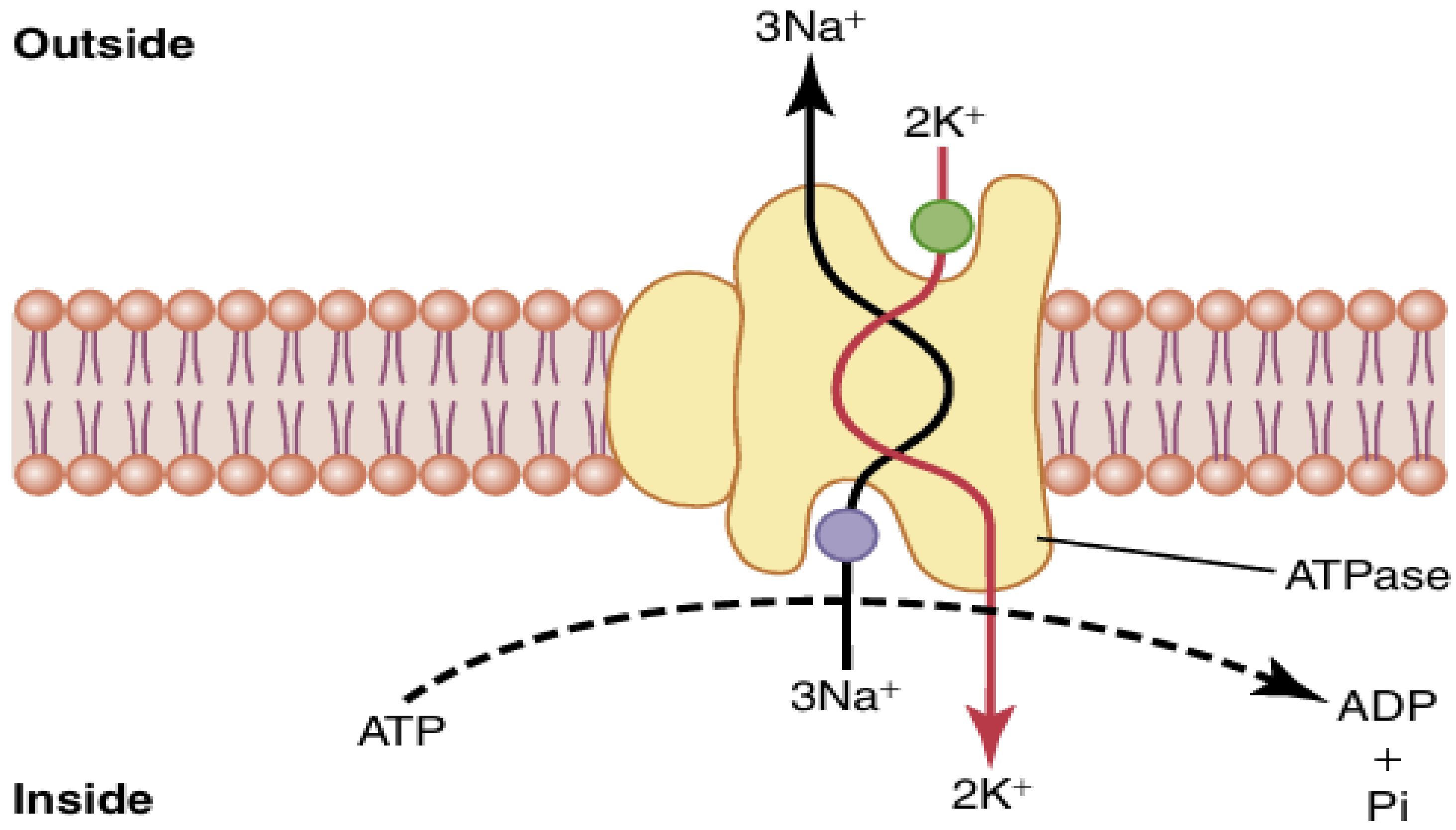
Physiology of Cell(Plasma) Membrane



Physiology of Cell(Plasma) Membrane



Physiology of Cell(Plasma) Membrane



Physiology of Cell(Plasma) Membrane

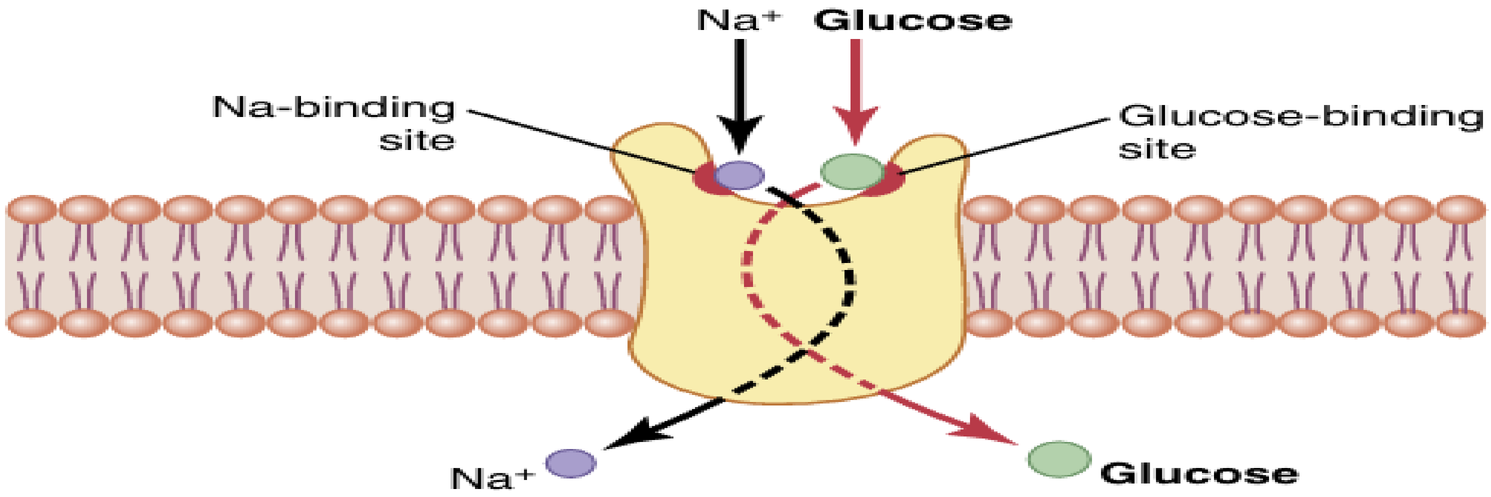
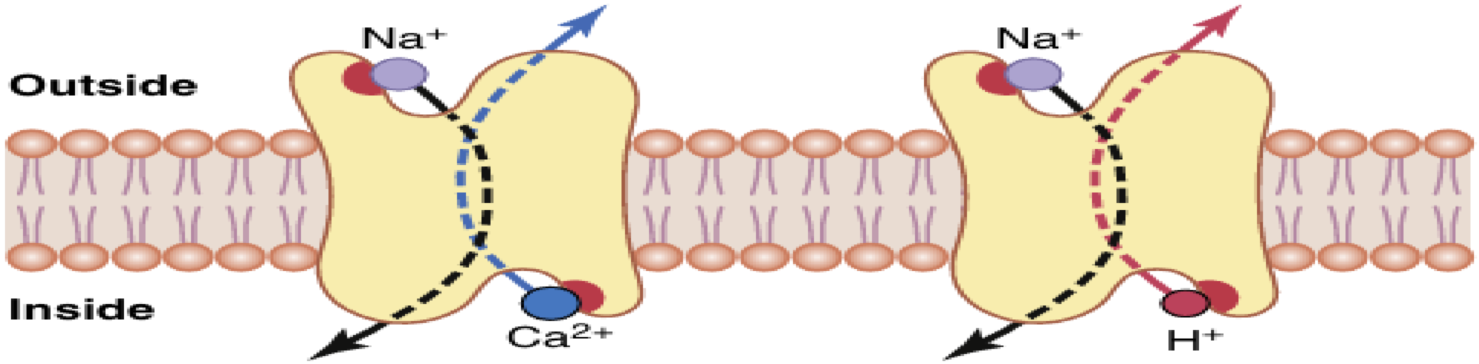
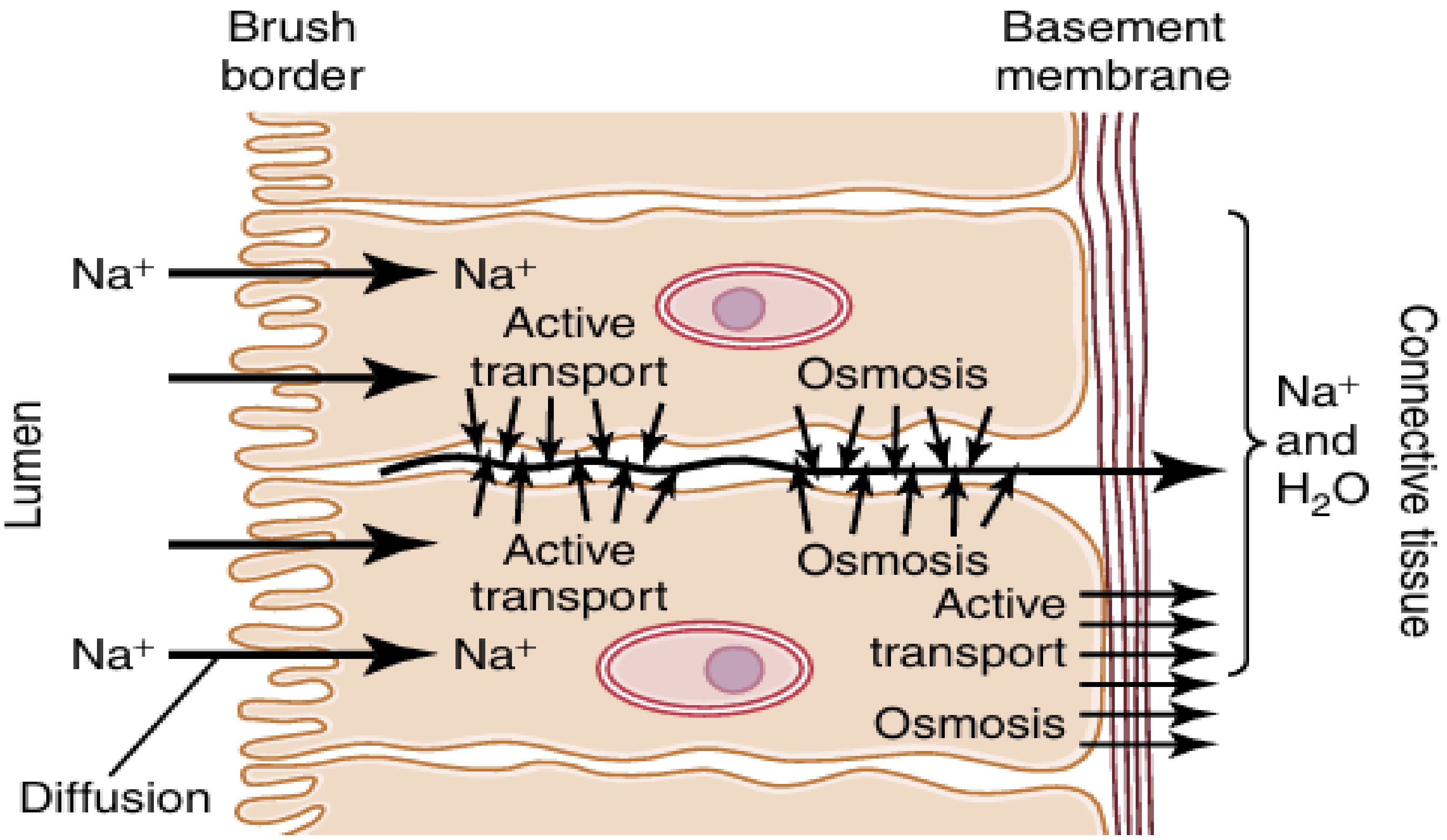


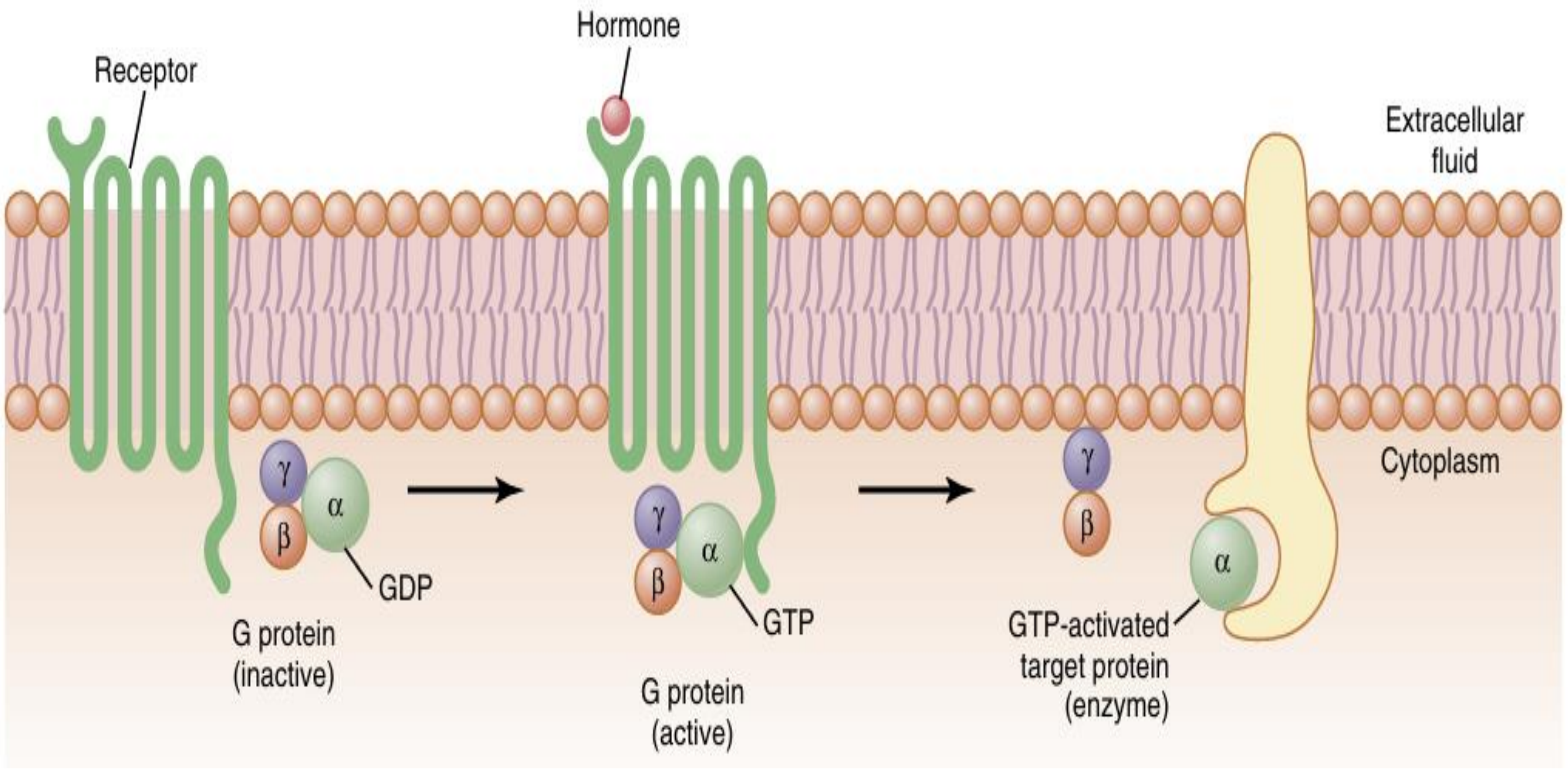
Figure 4-13 Postulated mechanism for sodium co-transport of glucose.



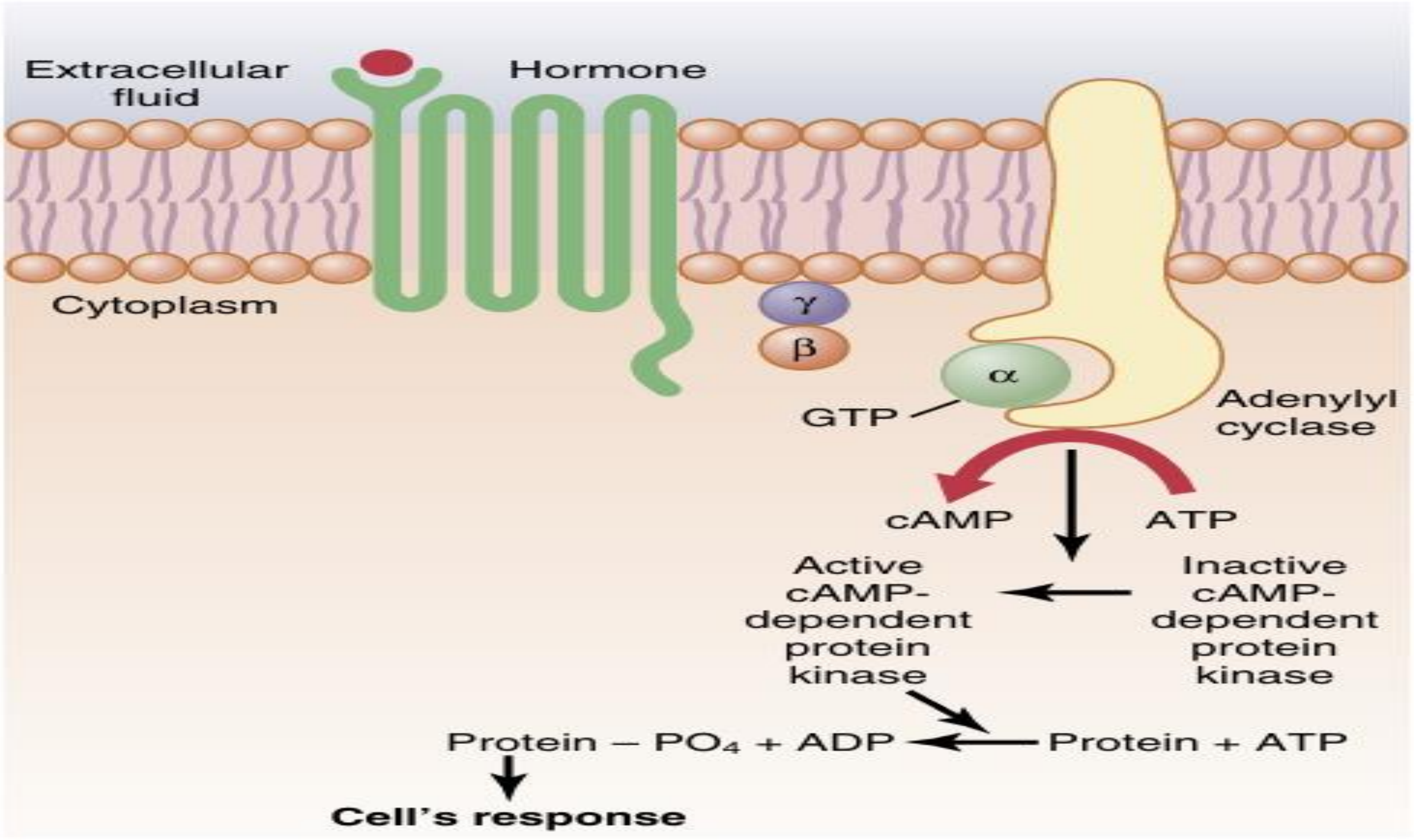
Physiology of Cell(Plasma) Membrane



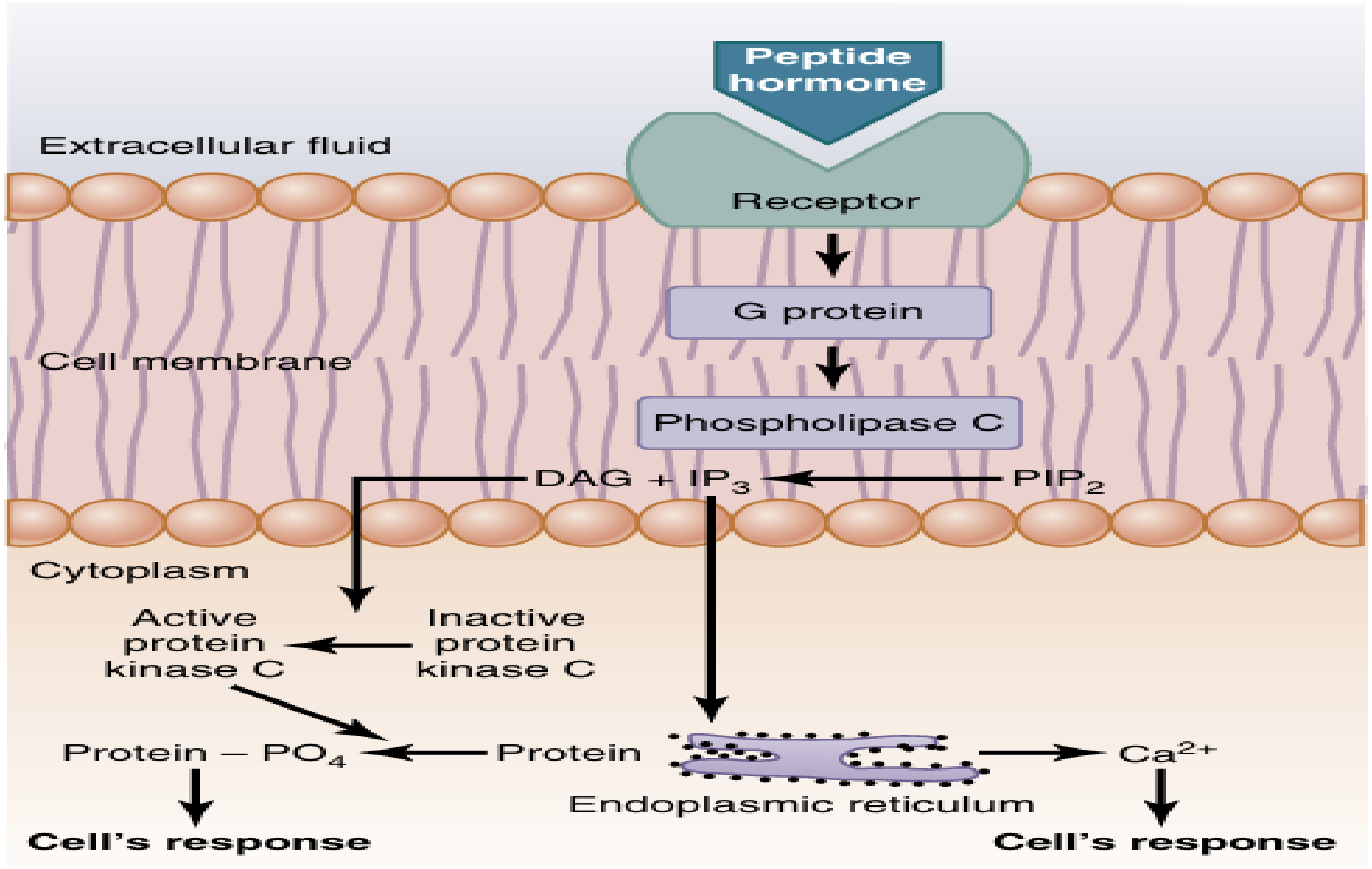
Physiology of Cell(Plasma) Membrane



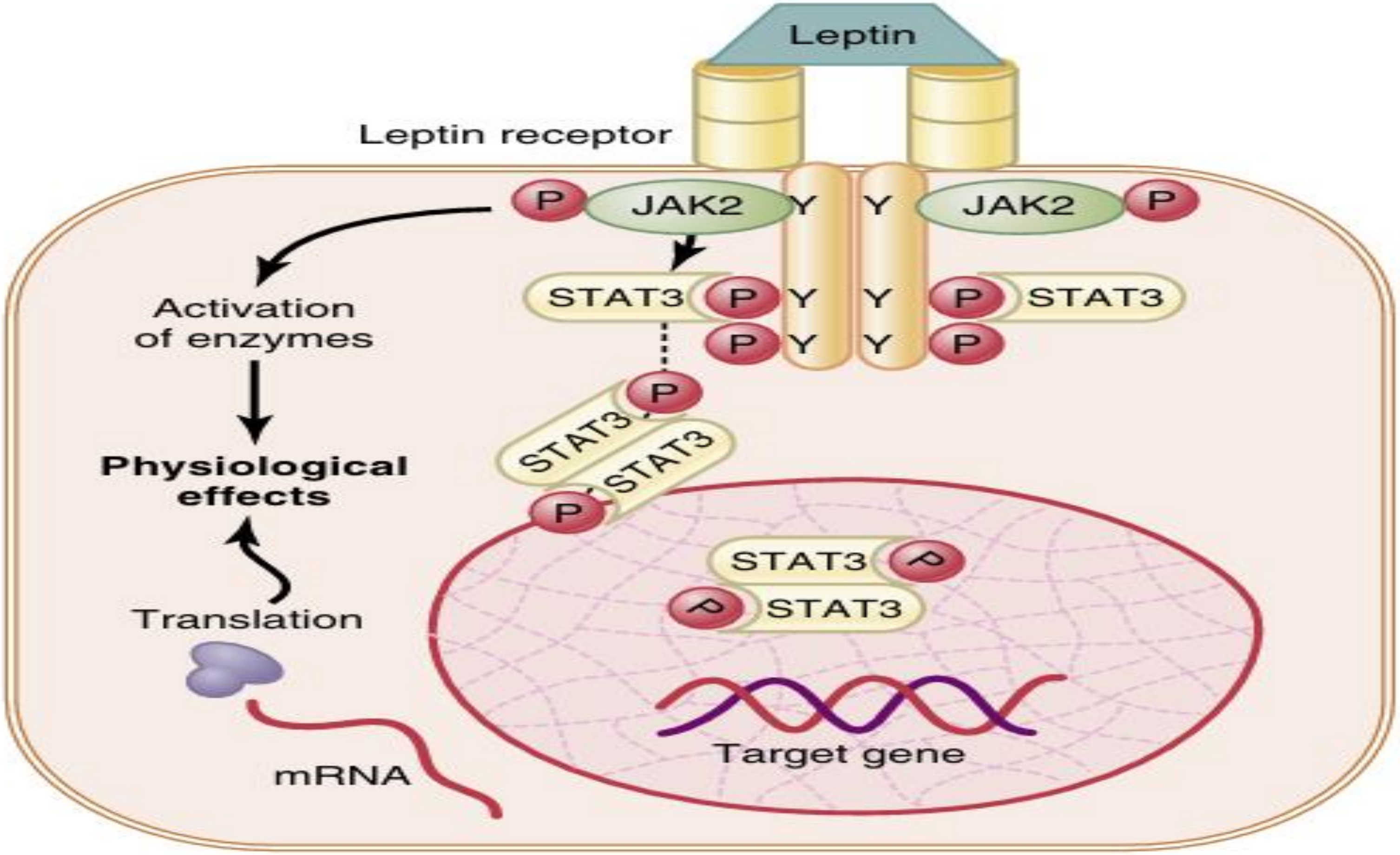
Physiology of Cell(Plasma) Membrane



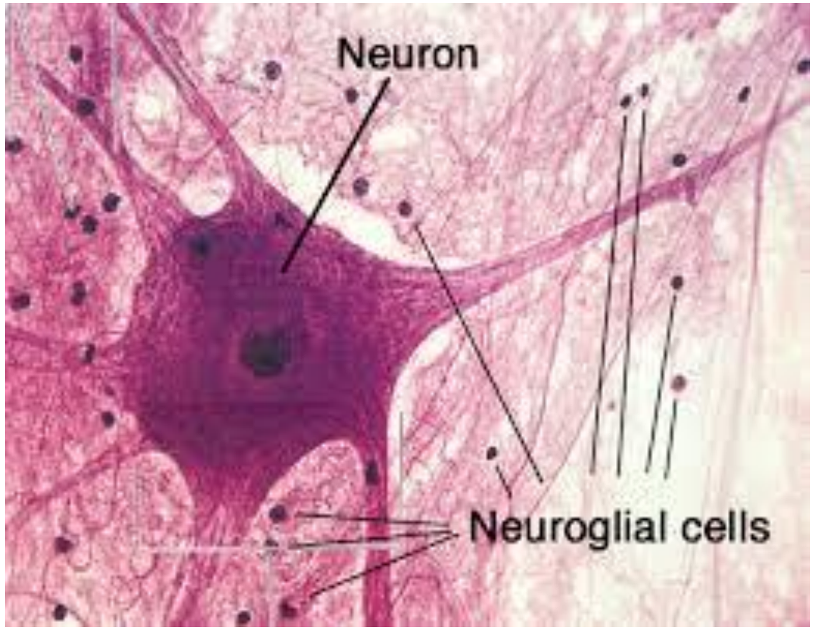
Physiology of Cell(Plasma) Membrane

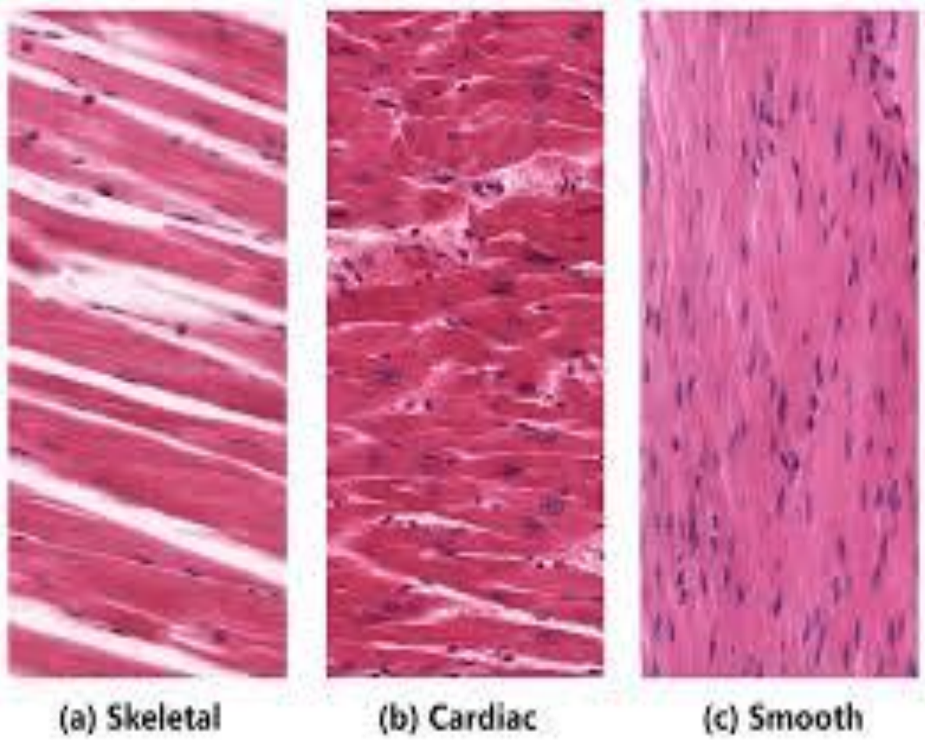


Physiology of Cell(Plasma) Membrane



Physiology of Excitable Cells





Physiology of Excitable Cells

Resting Membrane Potential(RMP)

&

Action Potential

Physiology of Excitable Cells

Table 5-1 Resting Membrane Potential in Different Cell Types

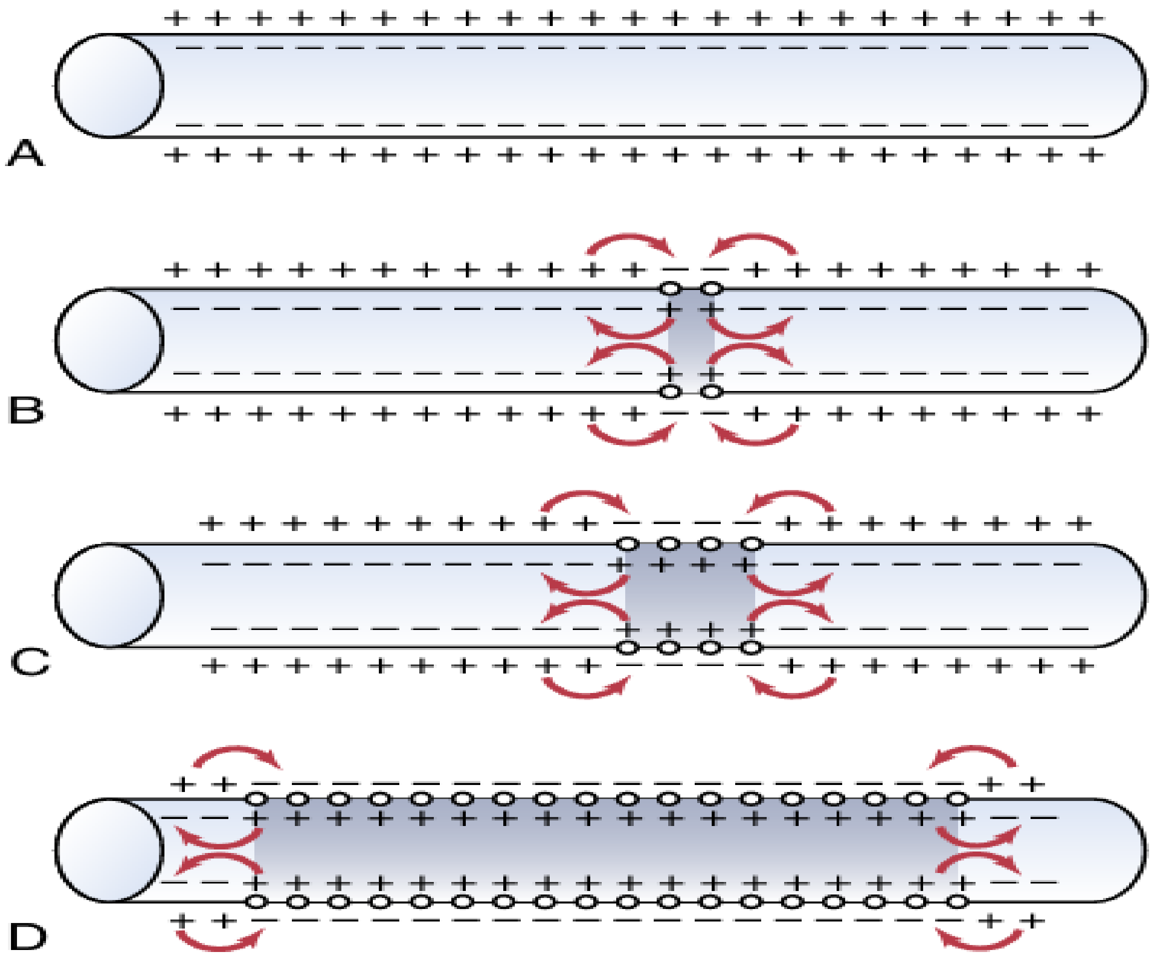
Cell Type	Resting Potential (mV)
Neurons	−60 to −70
Skeletal muscle	−85 to −95
Smooth muscle	−50 to −60
Cardiac muscle	−80 to −90
Hair (cochlea)	−15 to −40
Astrocyte	−80 to −90
Erythrocyte	−8 to −12
Photoreceptor	−40 (dark) to −70 (light)

Physiology of Excitable Cells

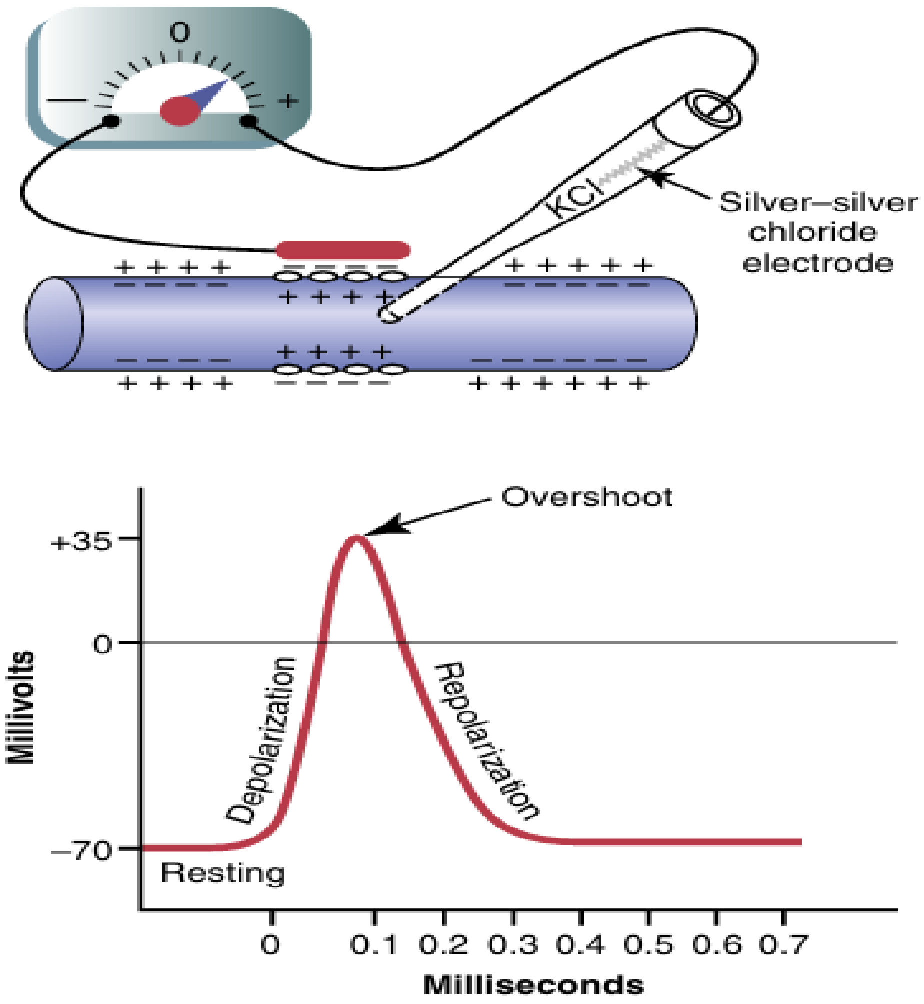
Action Potential

Depolarization & Repolarization

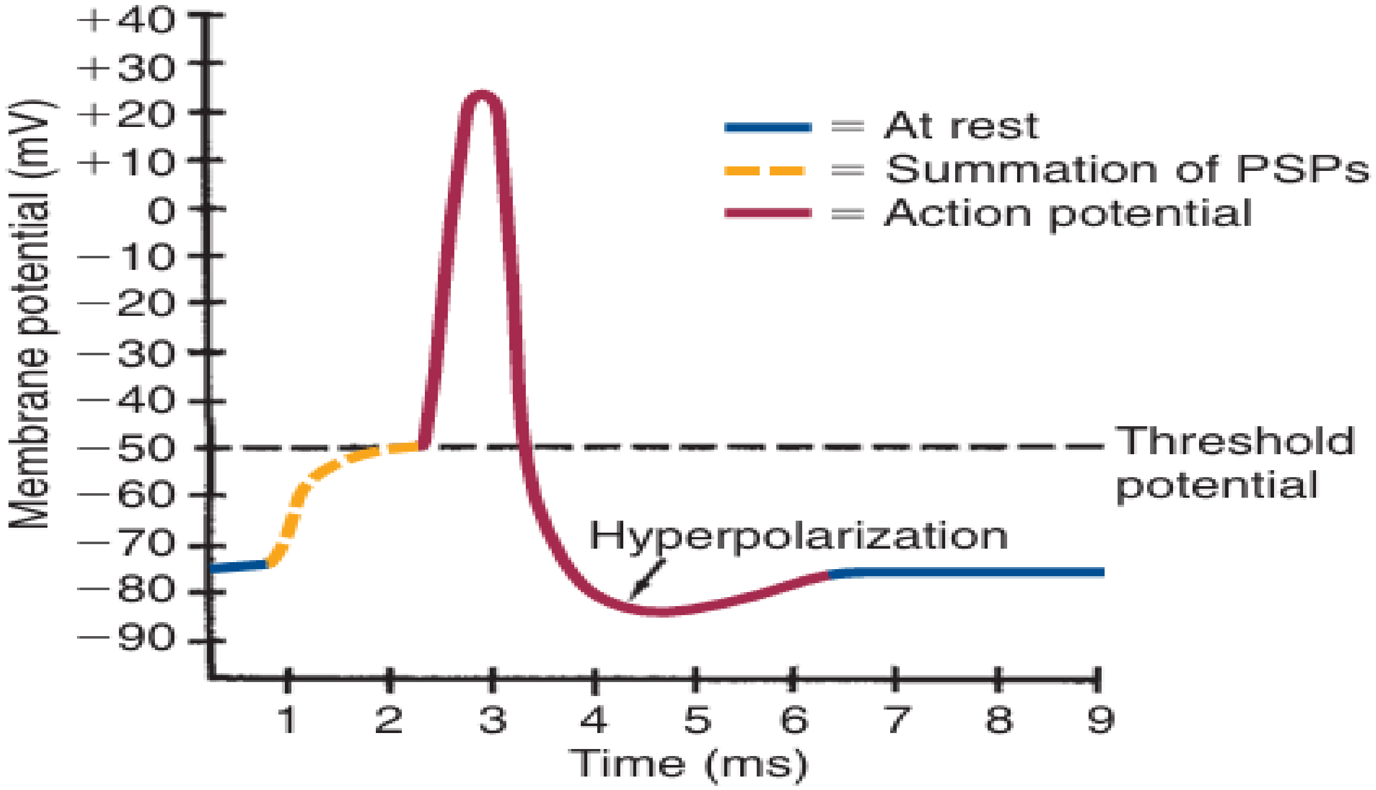
Physiology of Excitable Cells



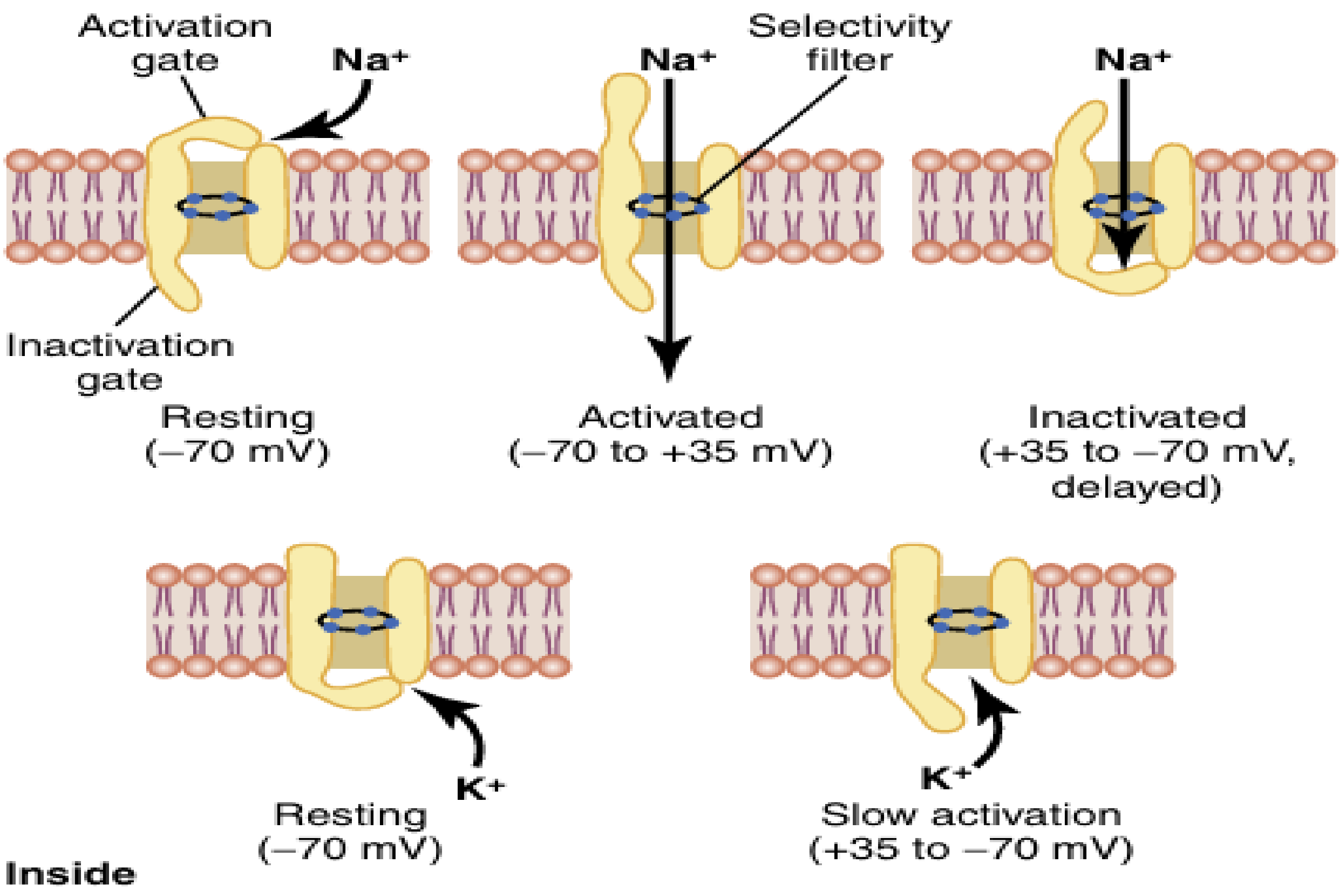
Physiology of Excitable Cells



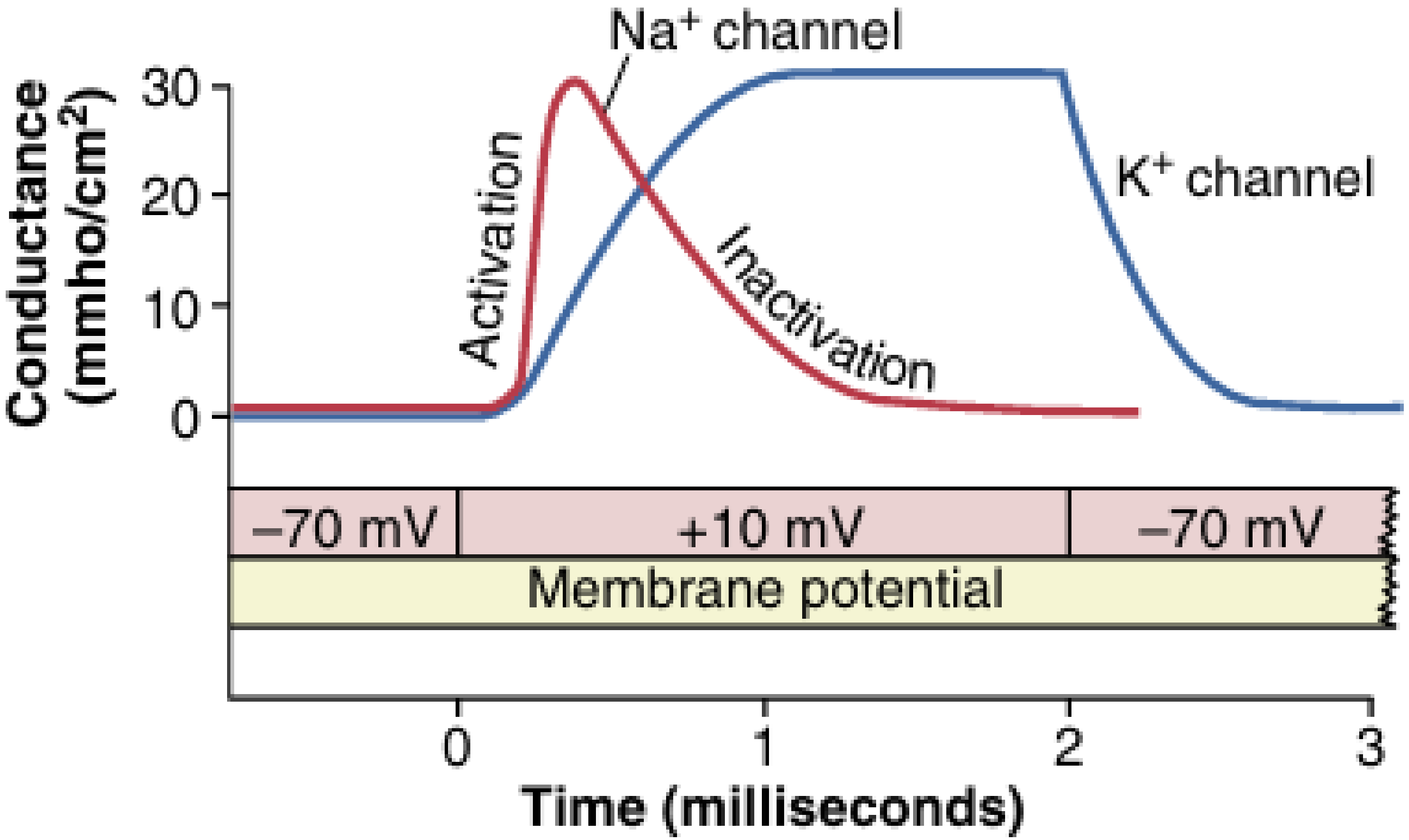
Physiology of Excitable Cells



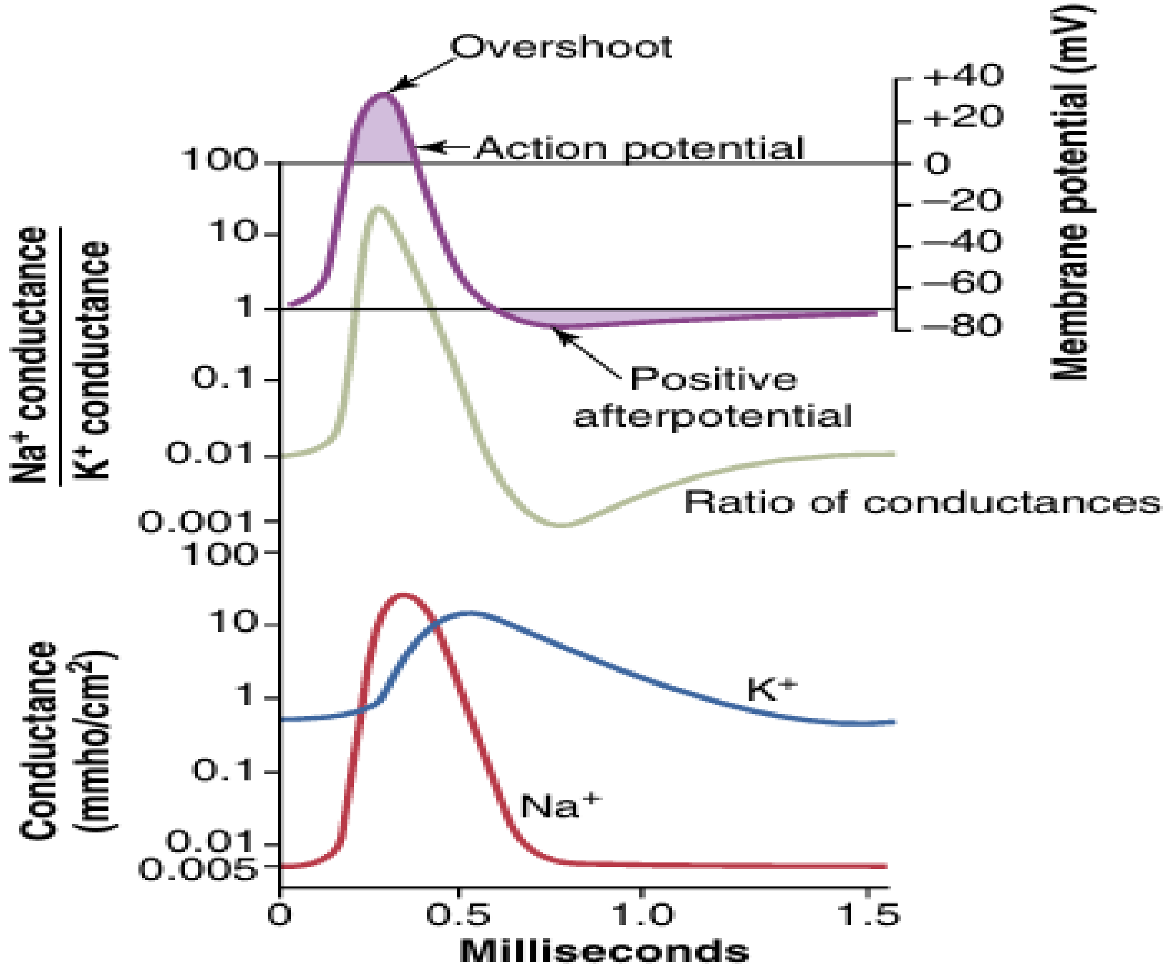
Physiology of Excitable Cells



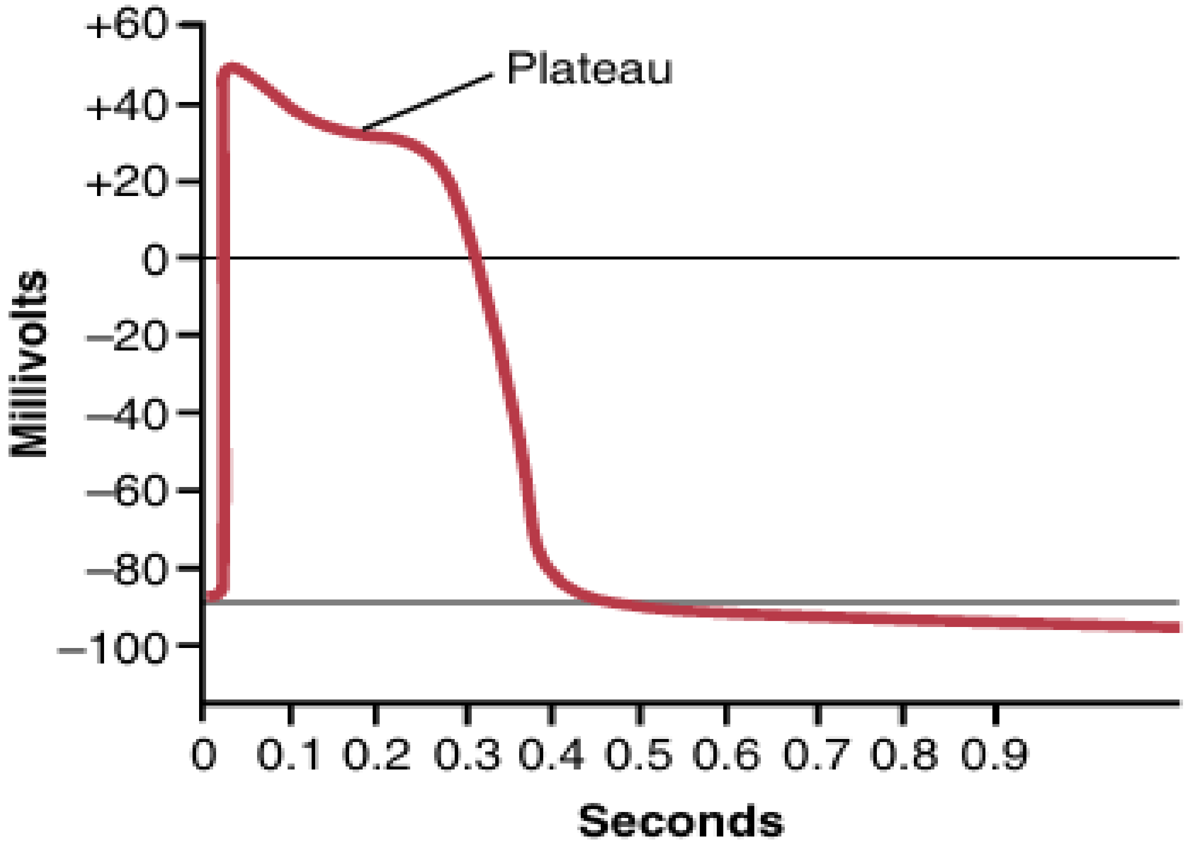
Physiology of Excitable Cells



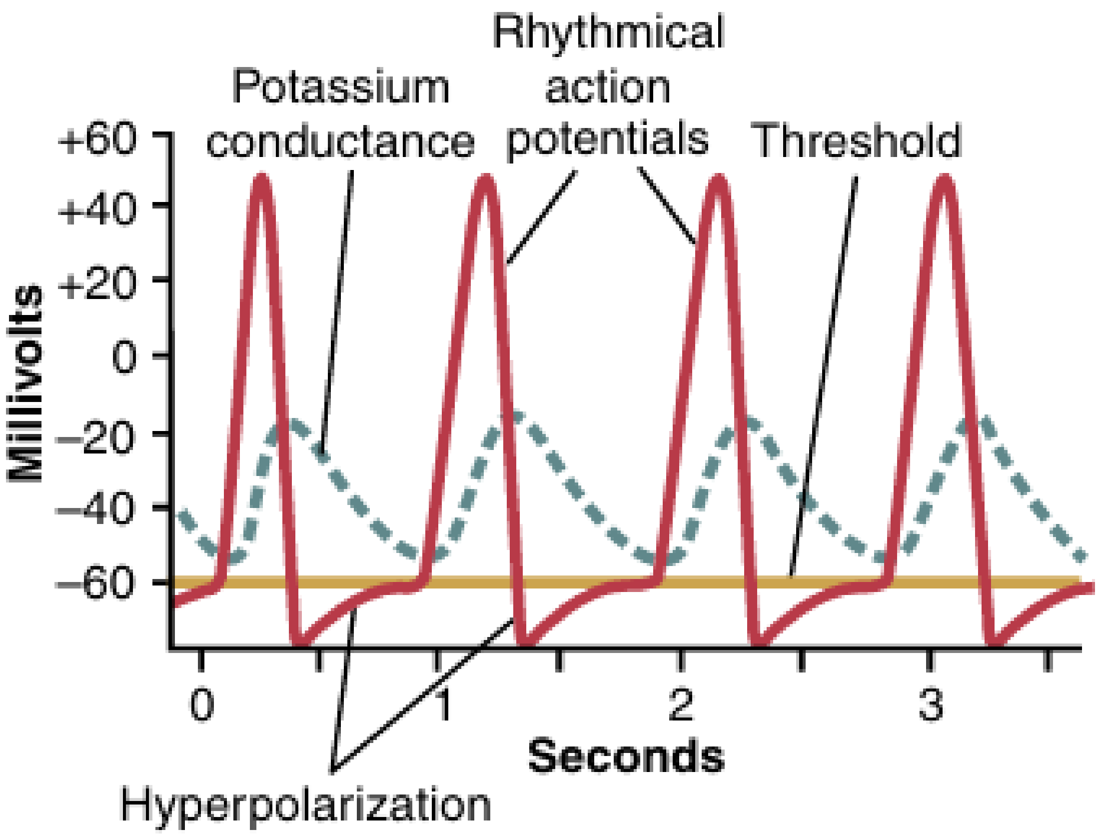
Physiology of Excitable Cells



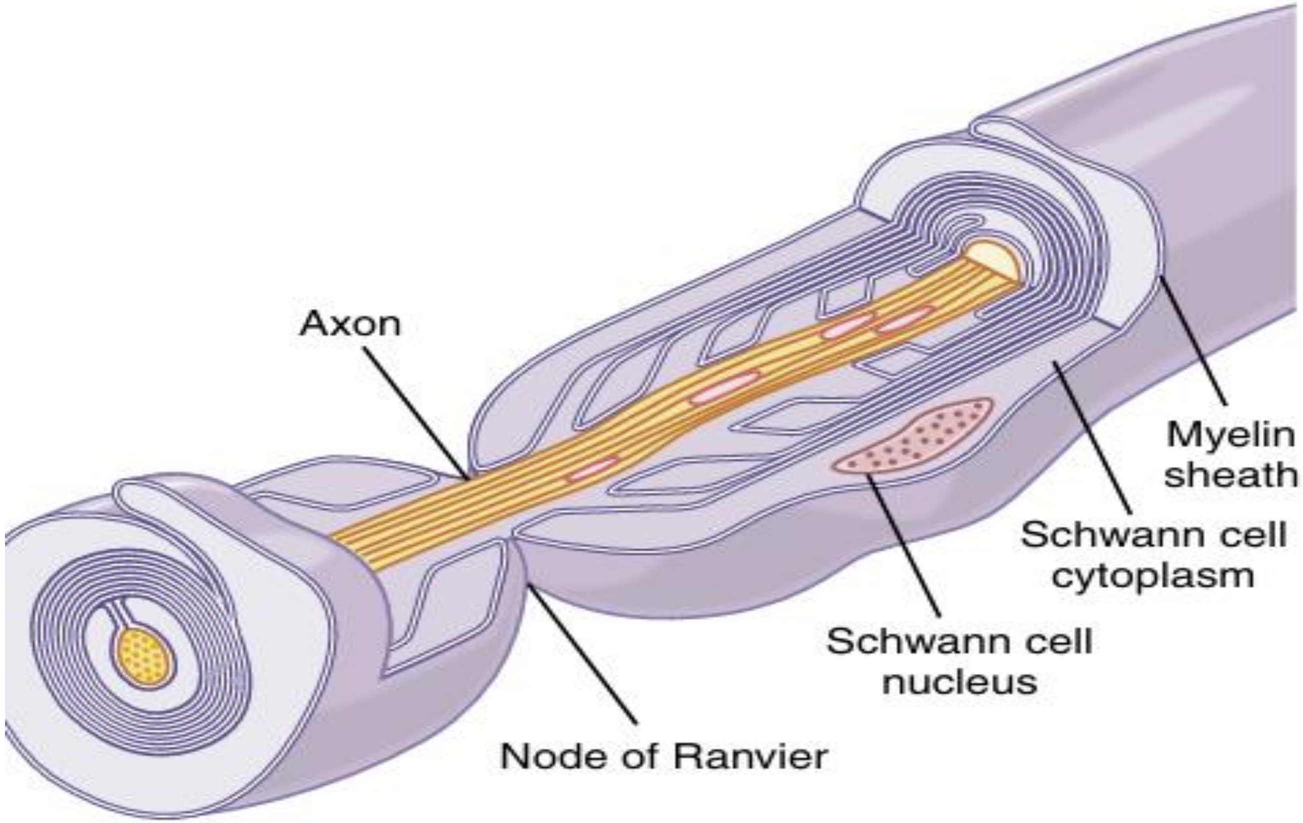
Physiology of Excitable Cells



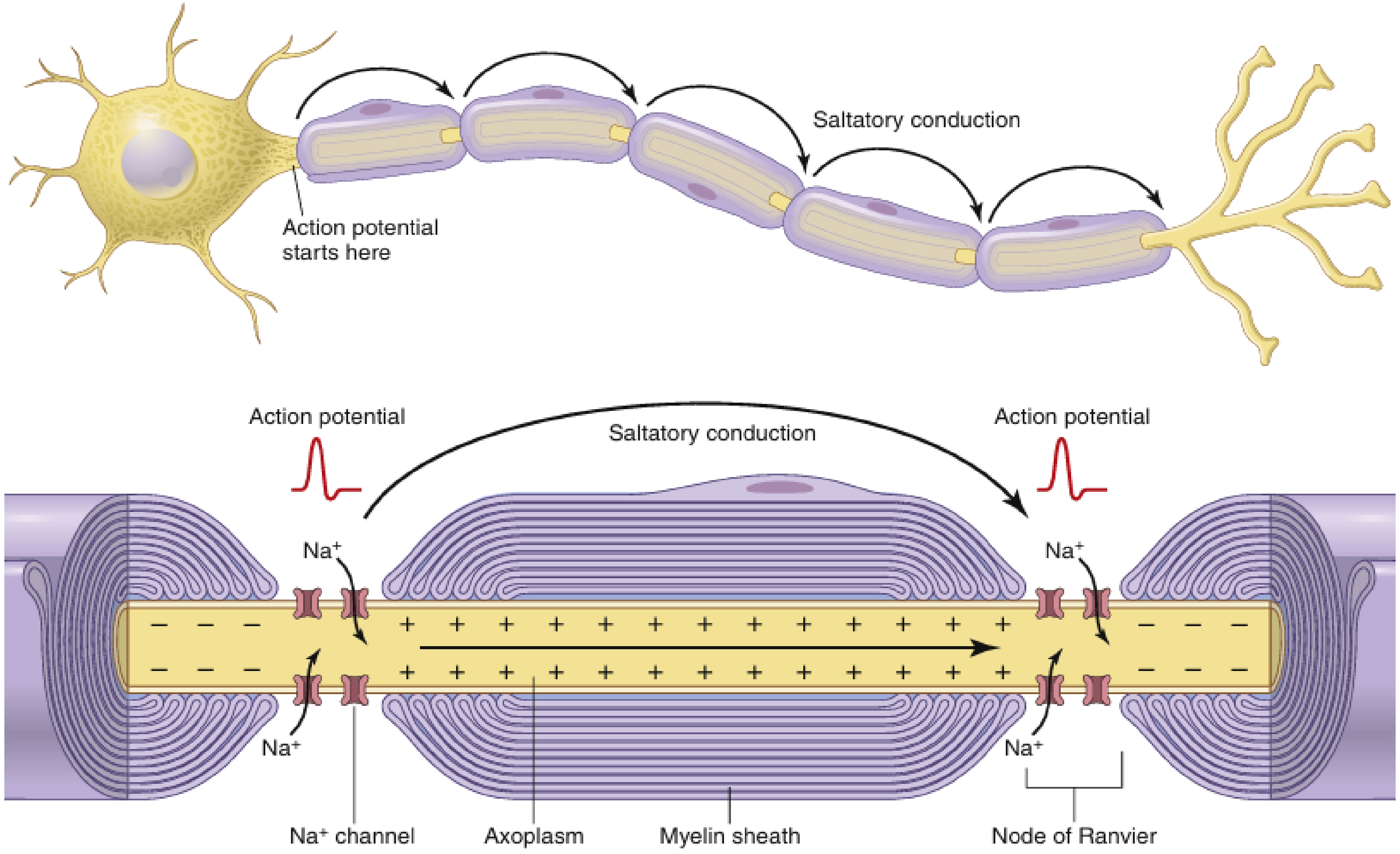
Physiology of Excitable Cells



Physiology of Excitable Cells



Physiology of Excitable Cells

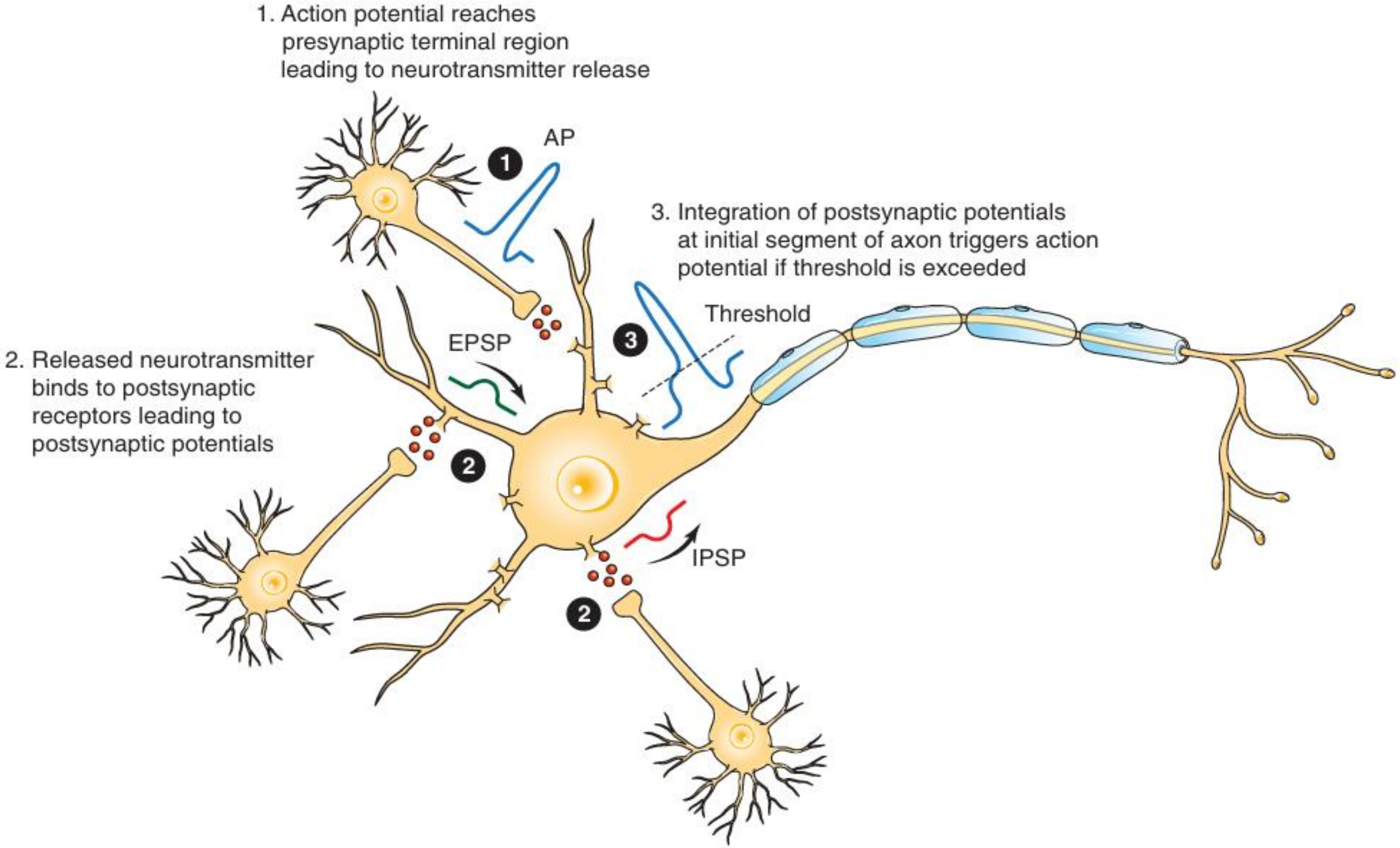


Physiology of Excitable Cells

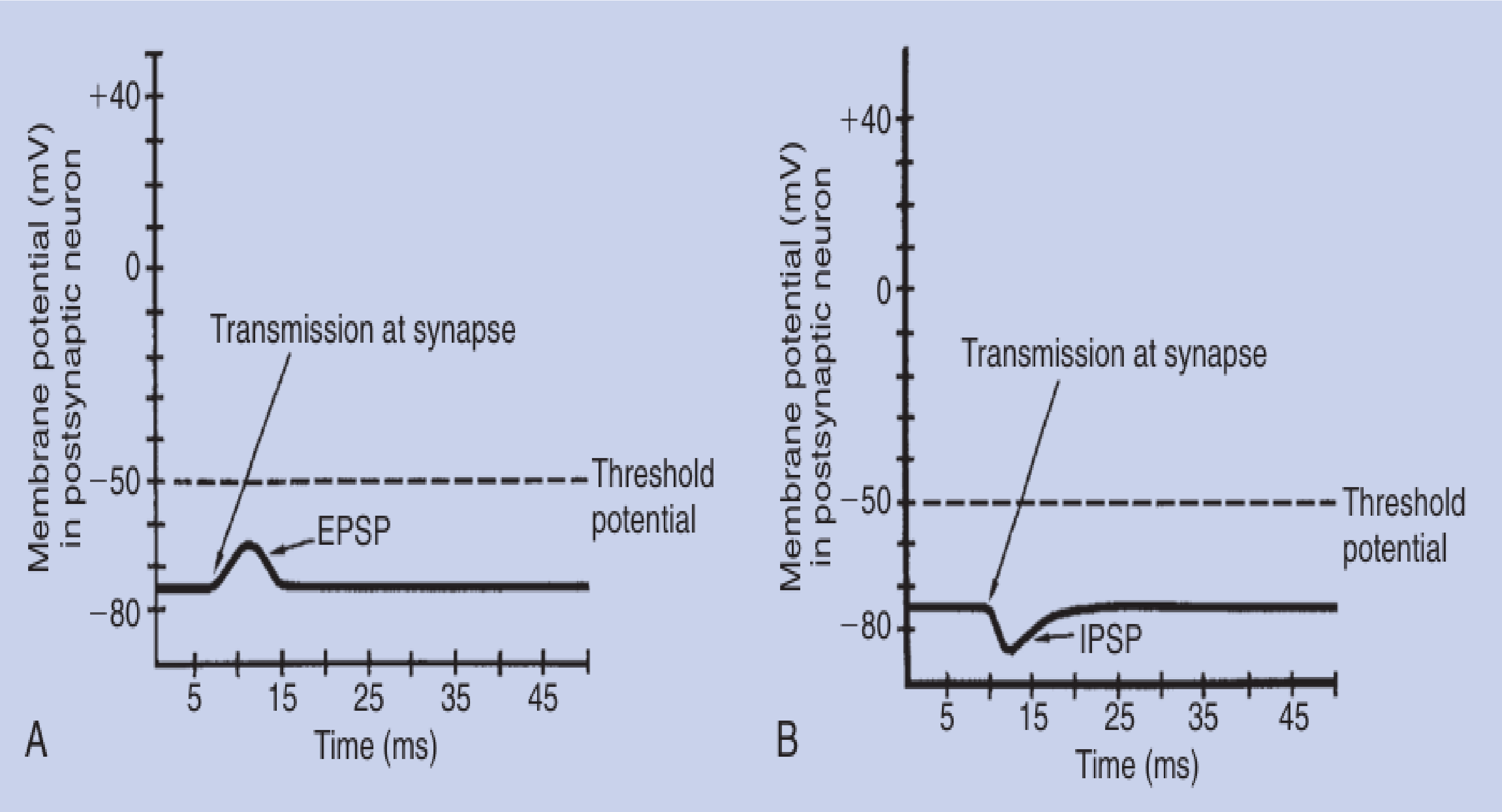
Postsynaptic Potentials

EPSP & IPSP

Physiology of Excitable Cells

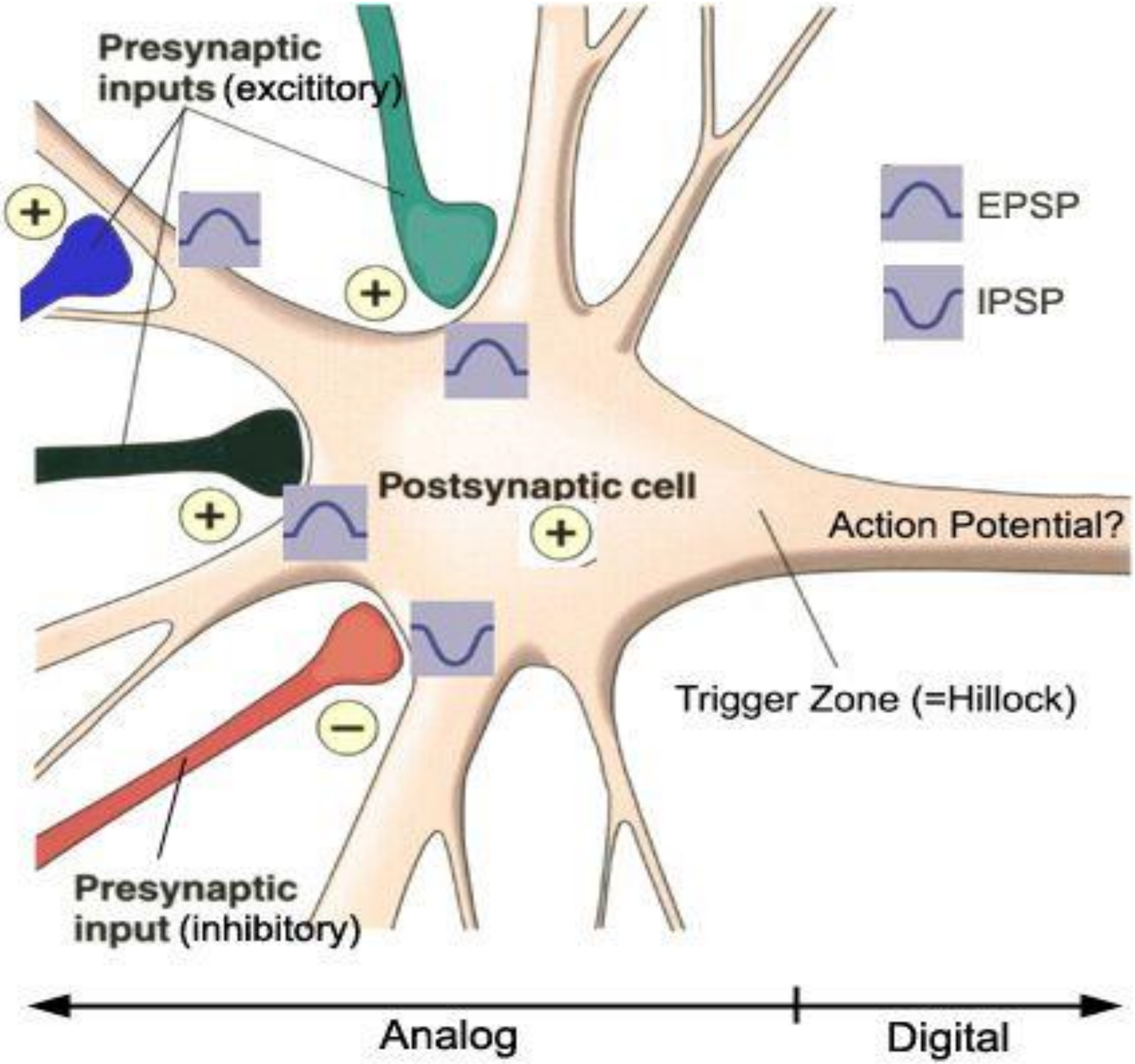


Physiology of Excitable Cells

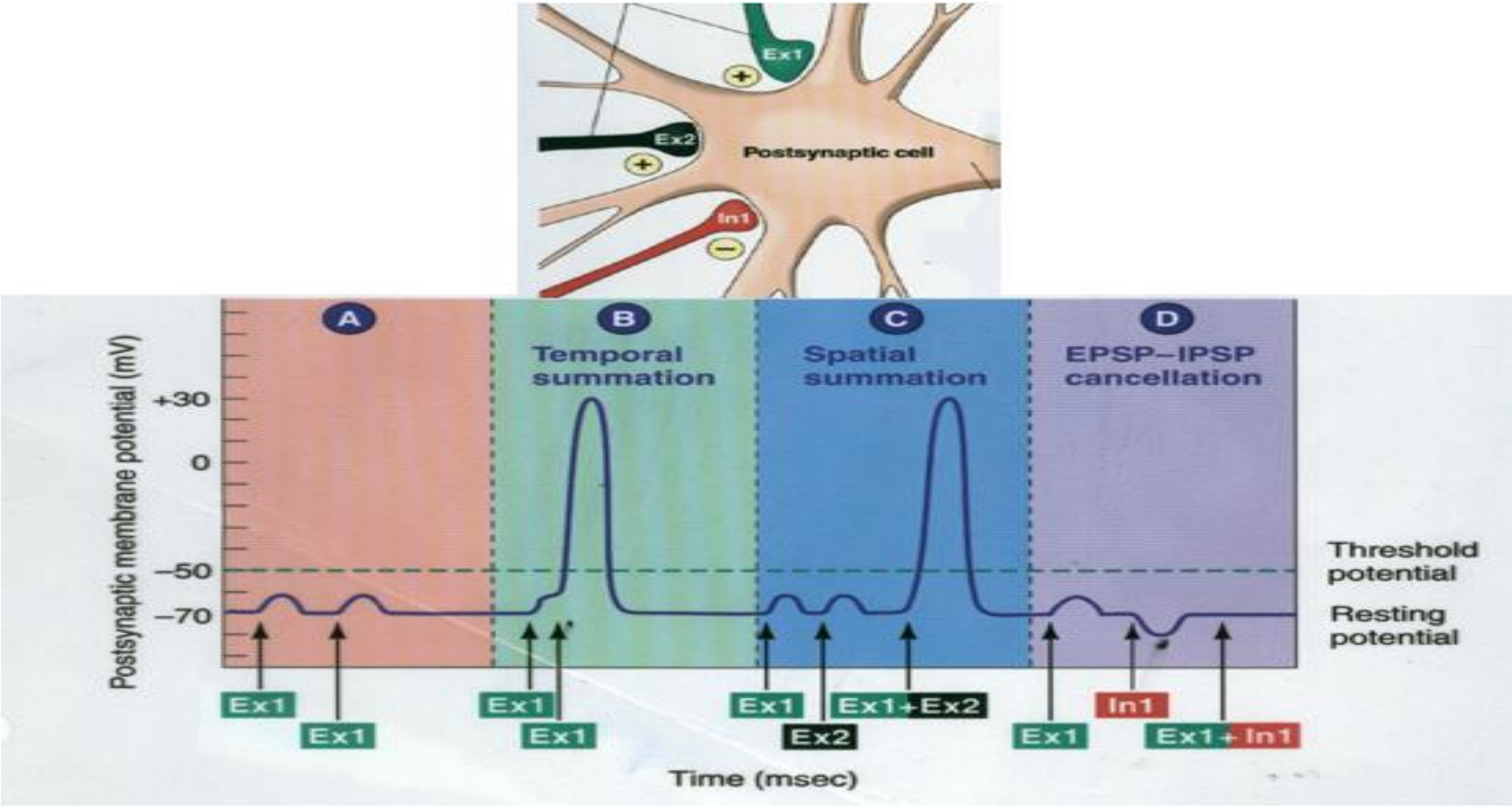


Physiology of Excitable Cells

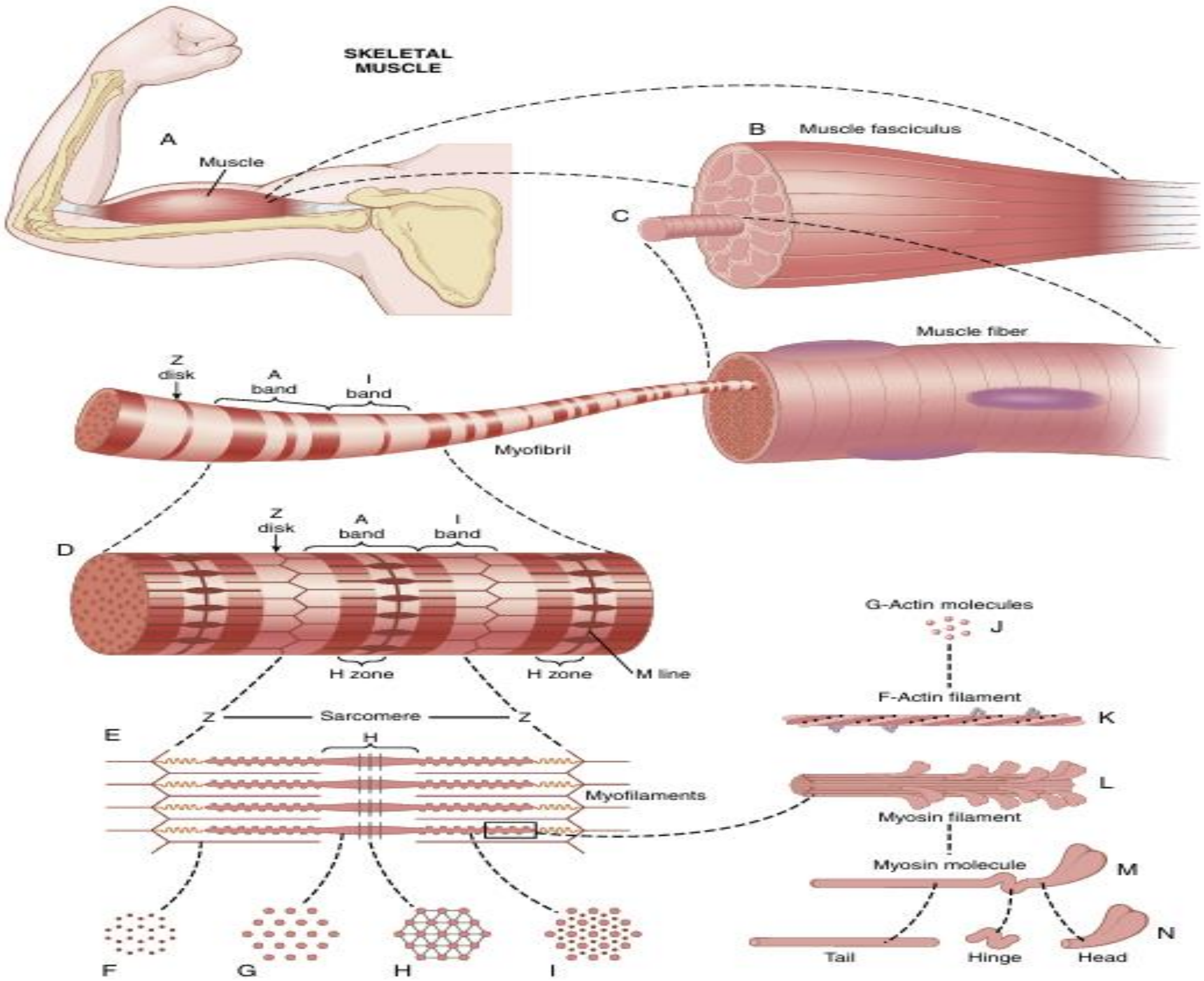
Temporal summation
&
Spatial summation


Presynaptic inputs (excititory)
EPSP
IPSP
Postsynaptic cell
Action Potential?
Trigger Zone (=Hillock)
Presynaptic input (inhibitory)
Analog
Digital

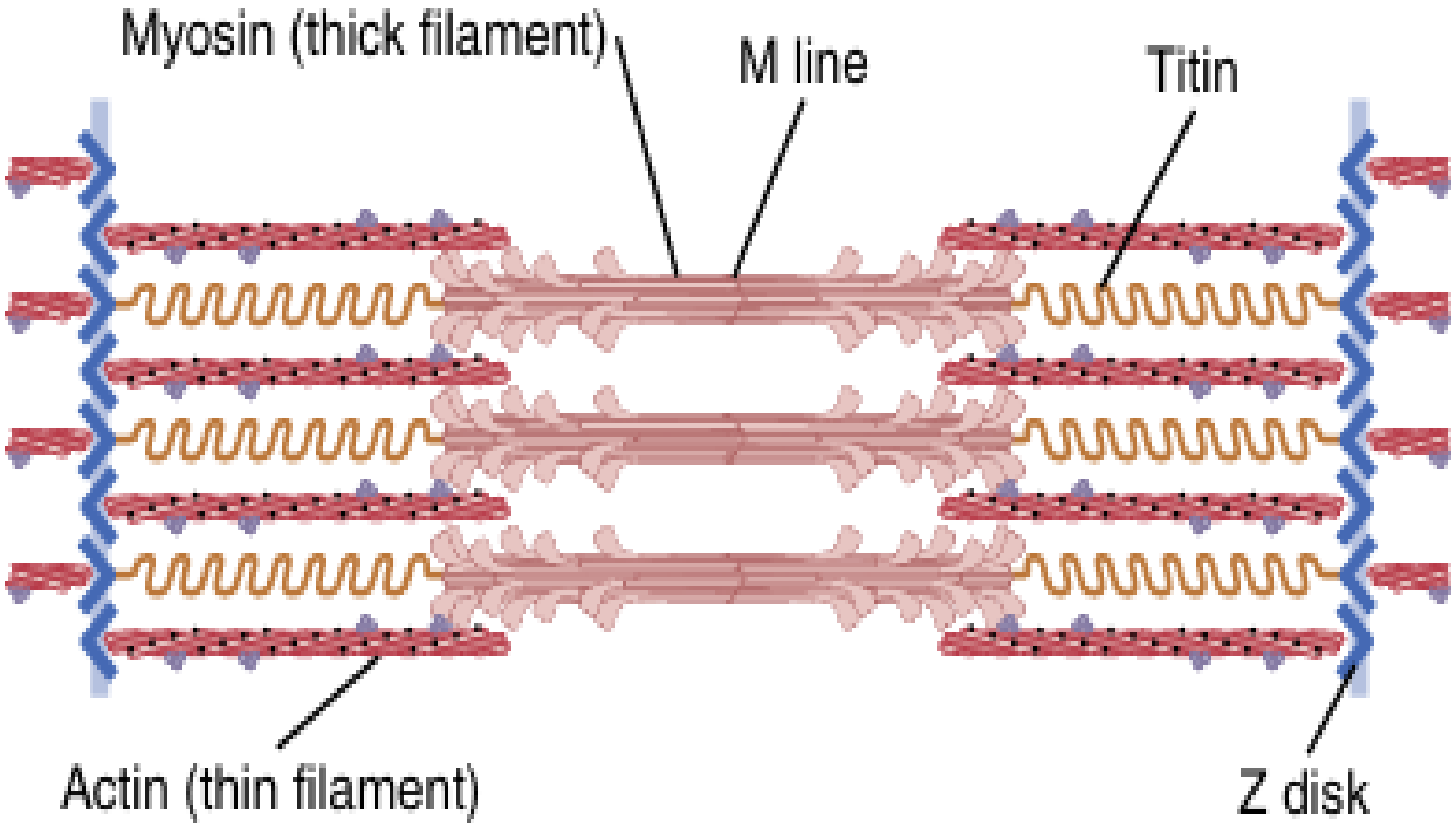
Physiology of Excitable Cells



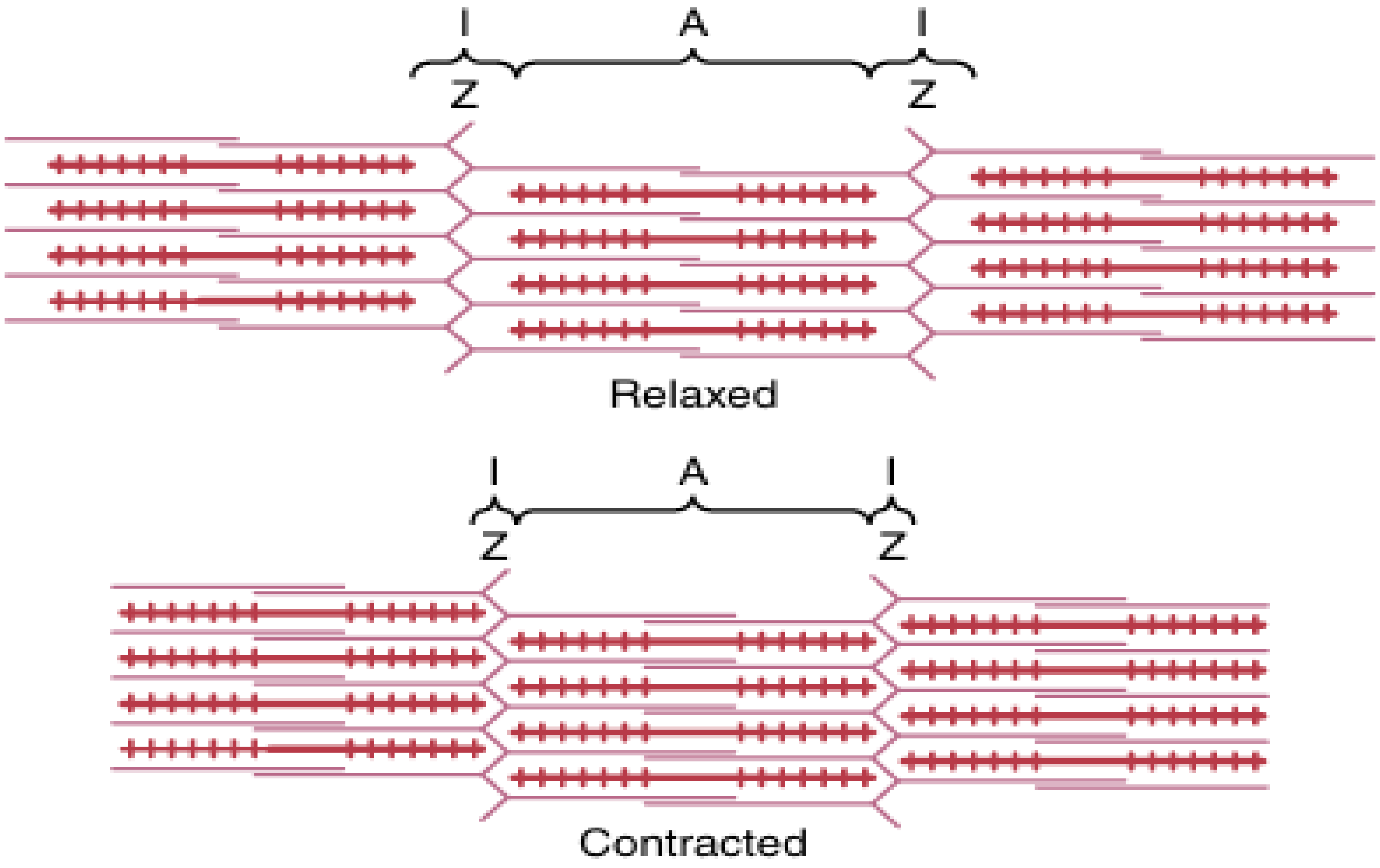
Physiology of Excitable Cells



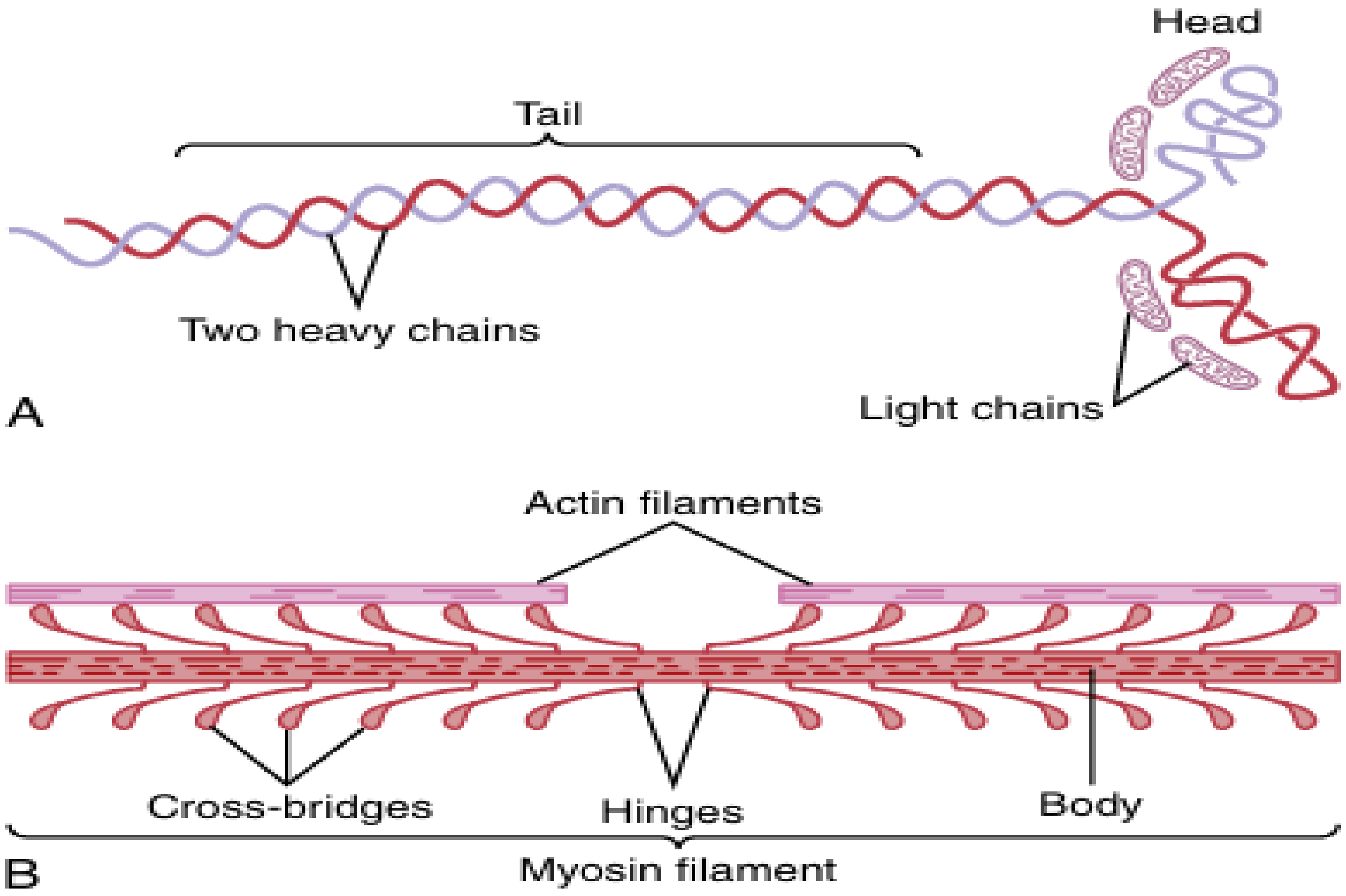
Physiology of Excitable Cells



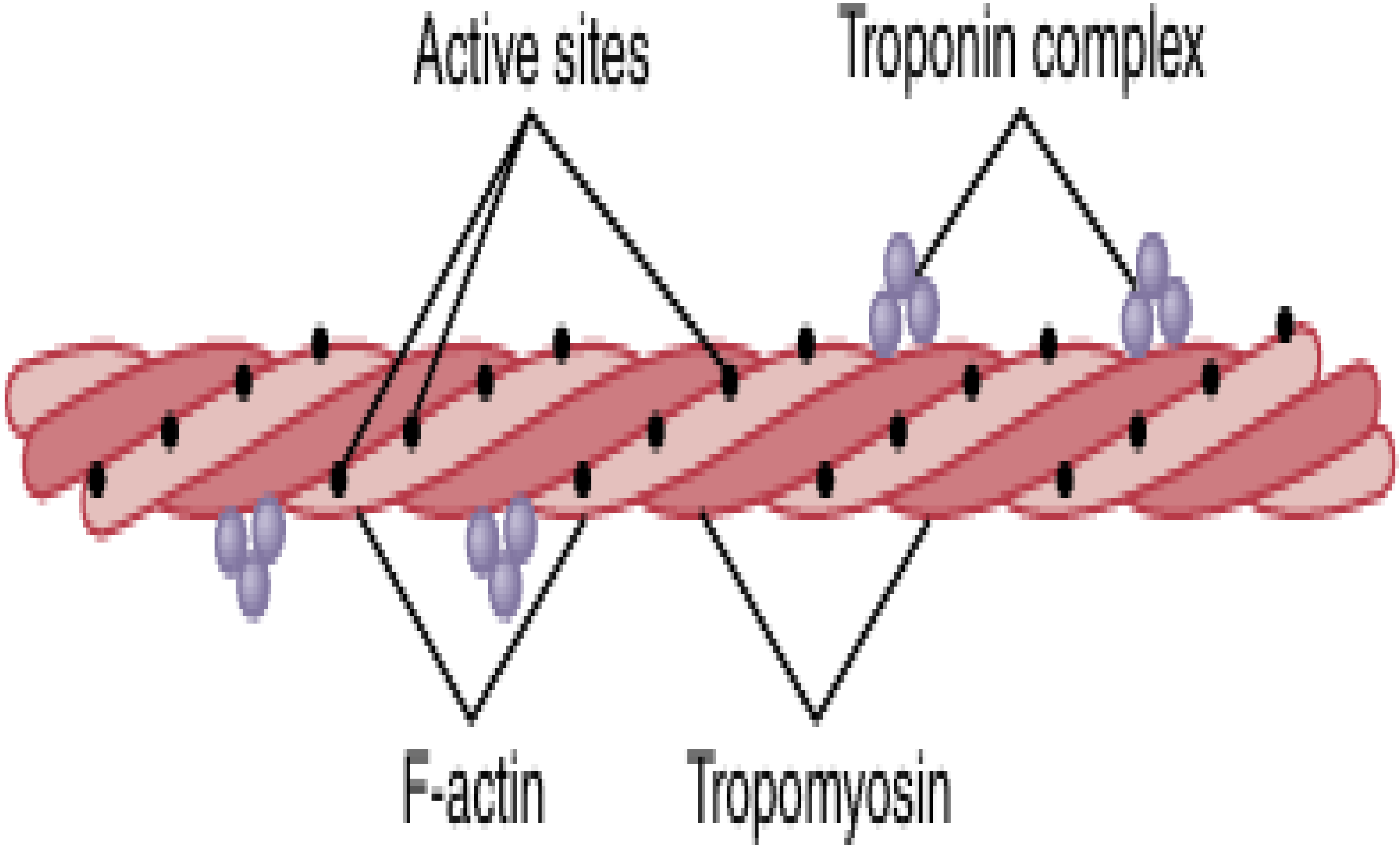
Physiology of Excitable Cells



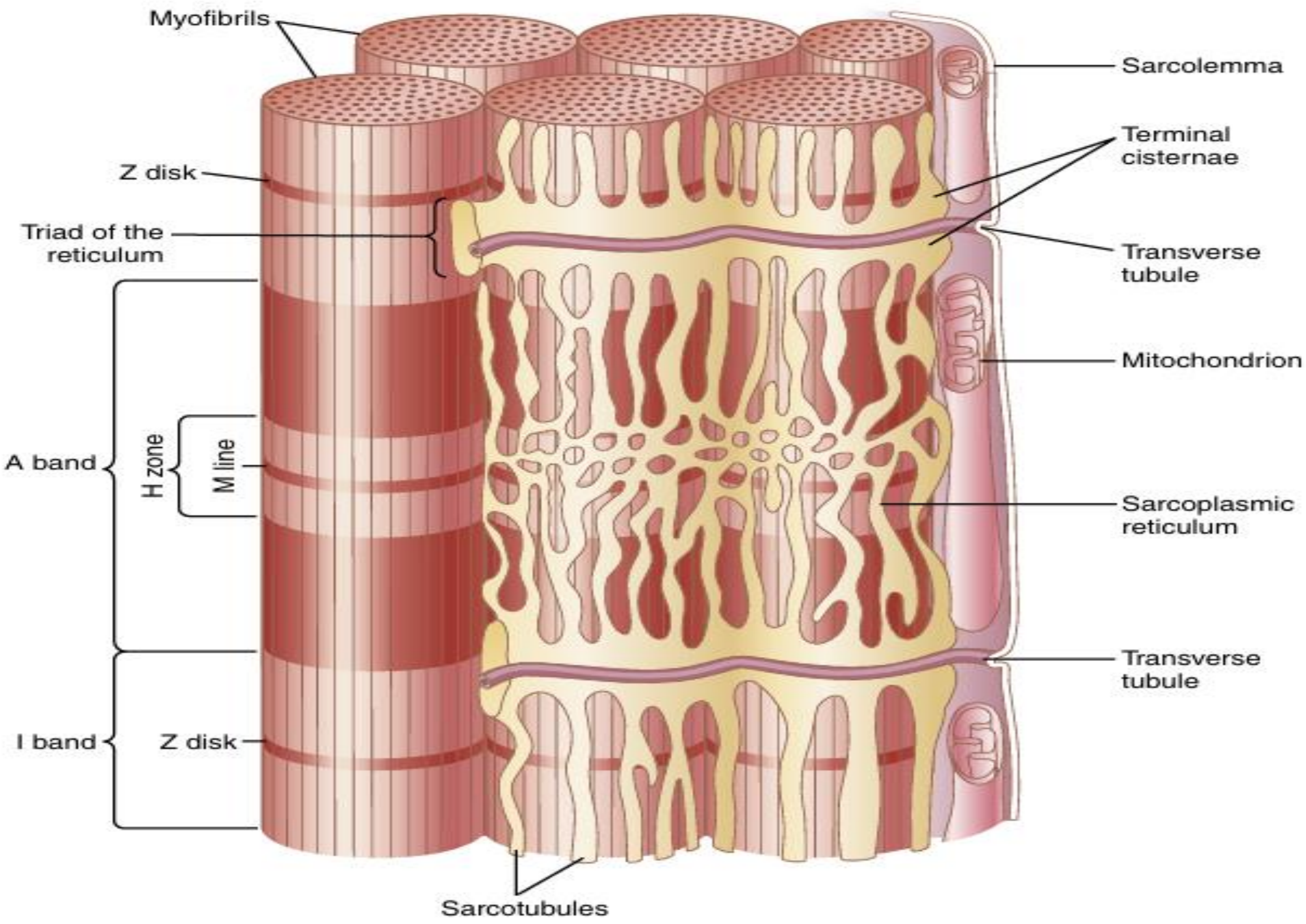
Physiology of Excitable Cells



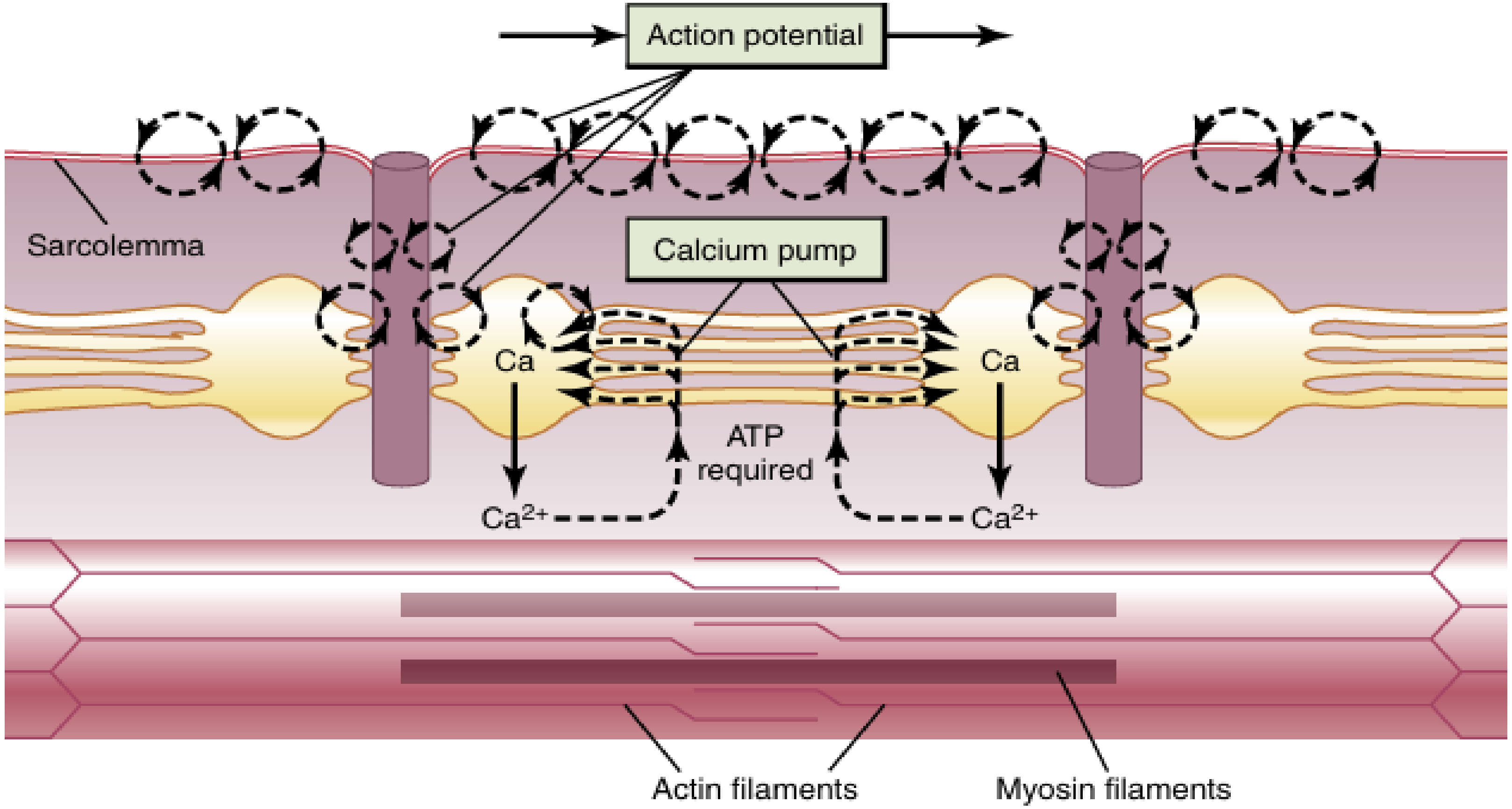
Physiology of Excitable Cells



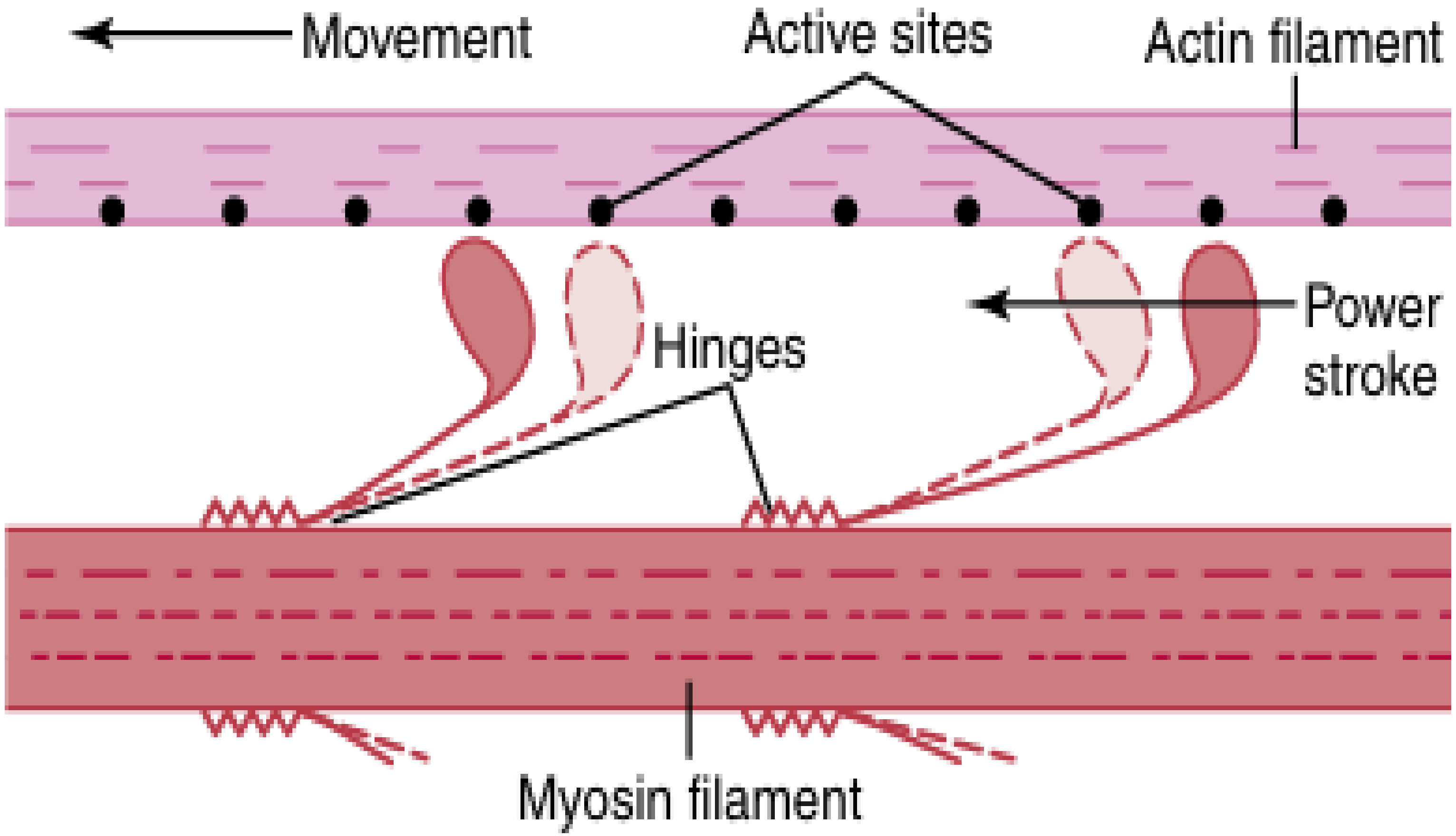
Physiology of Excitable Cells



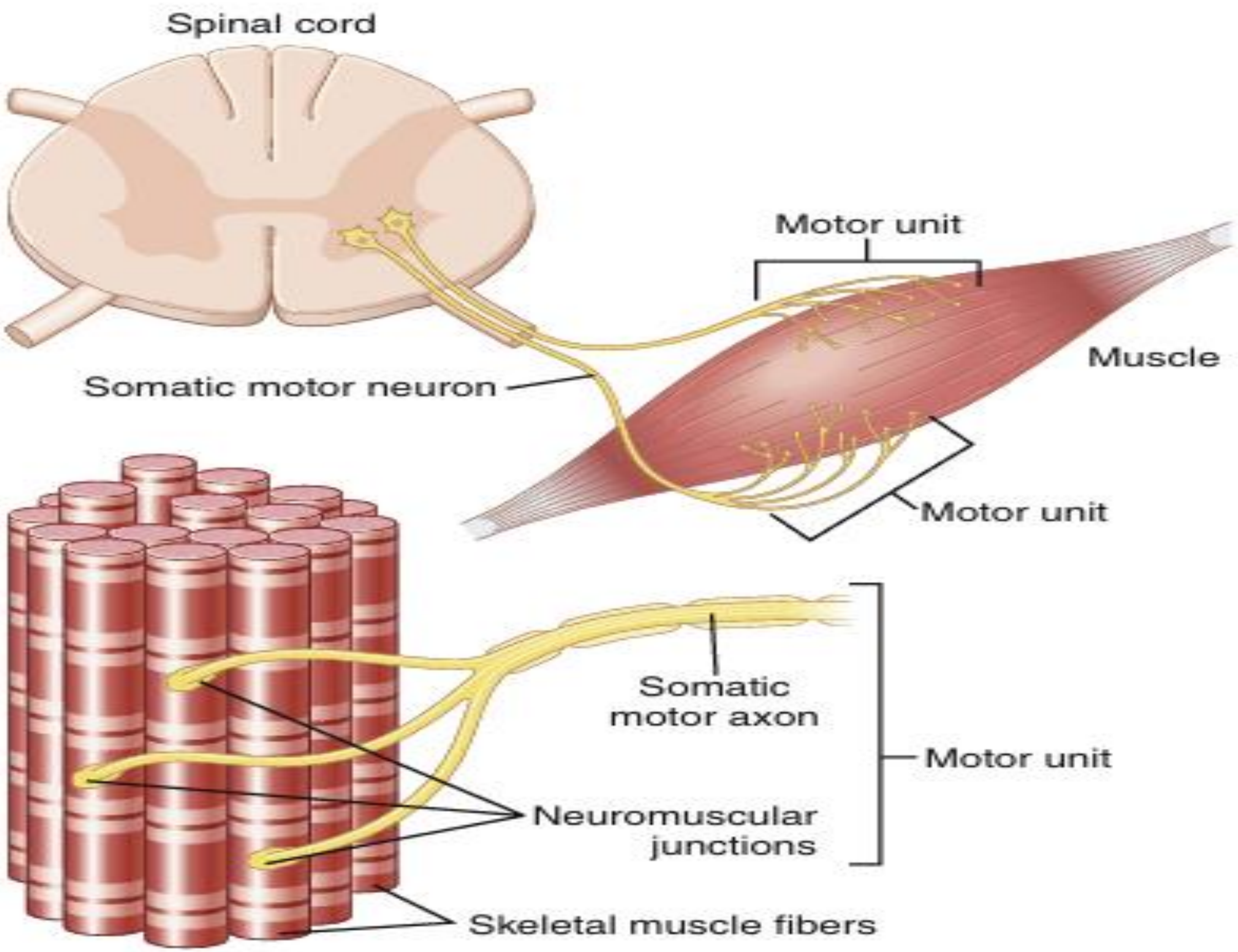
Physiology of Excitable Cells



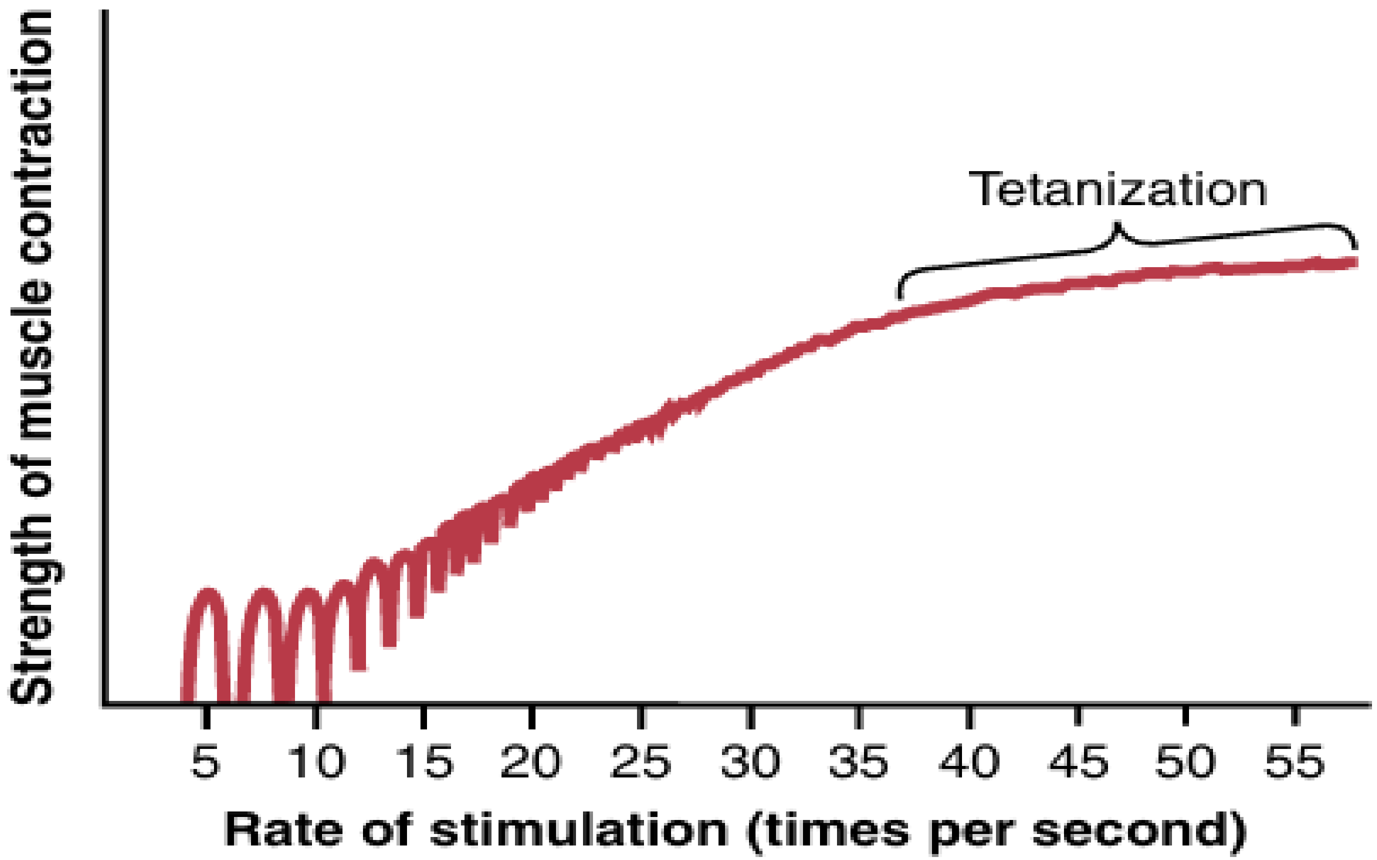
Physiology of Excitable Cells



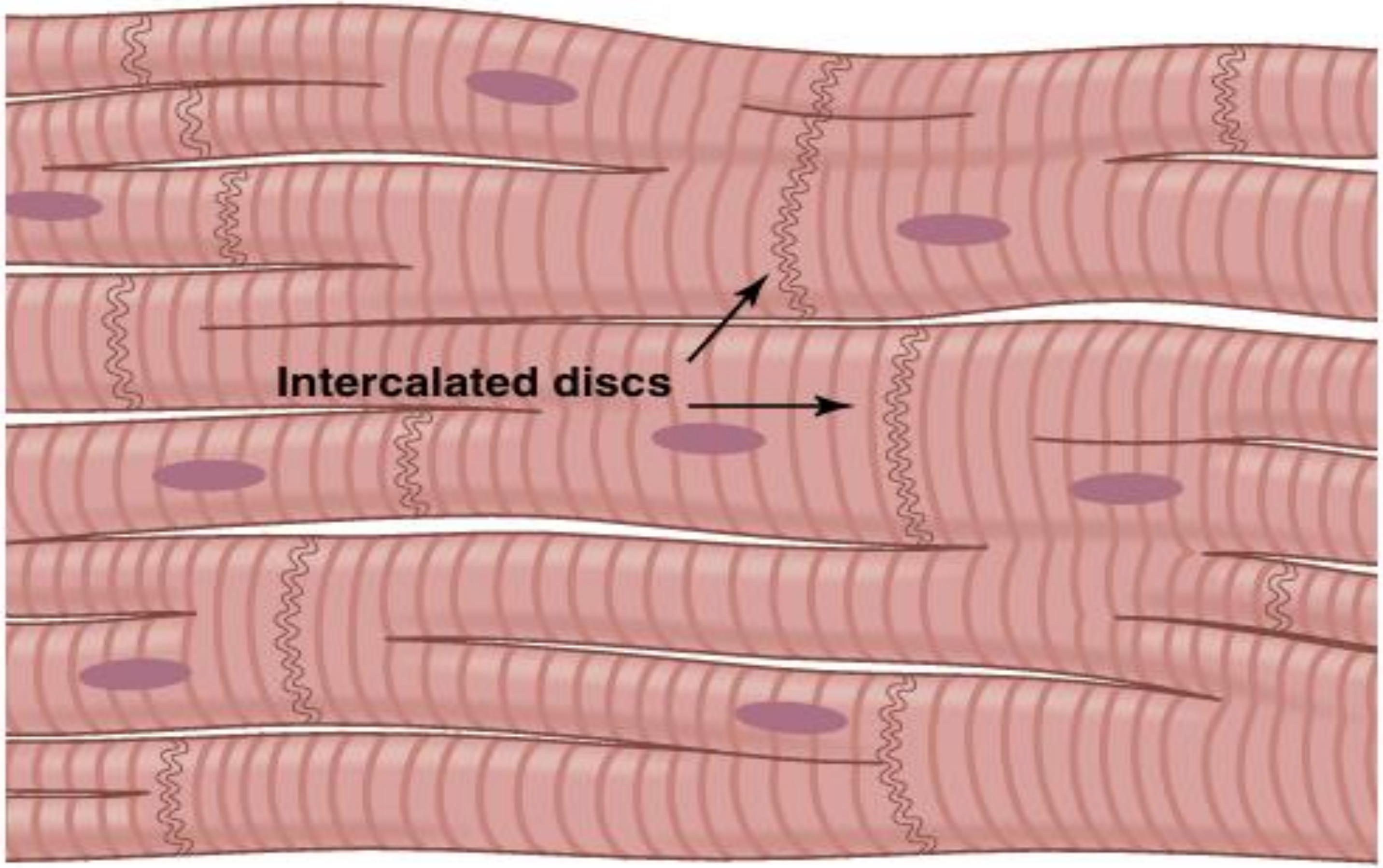
Physiology of Excitable Cells



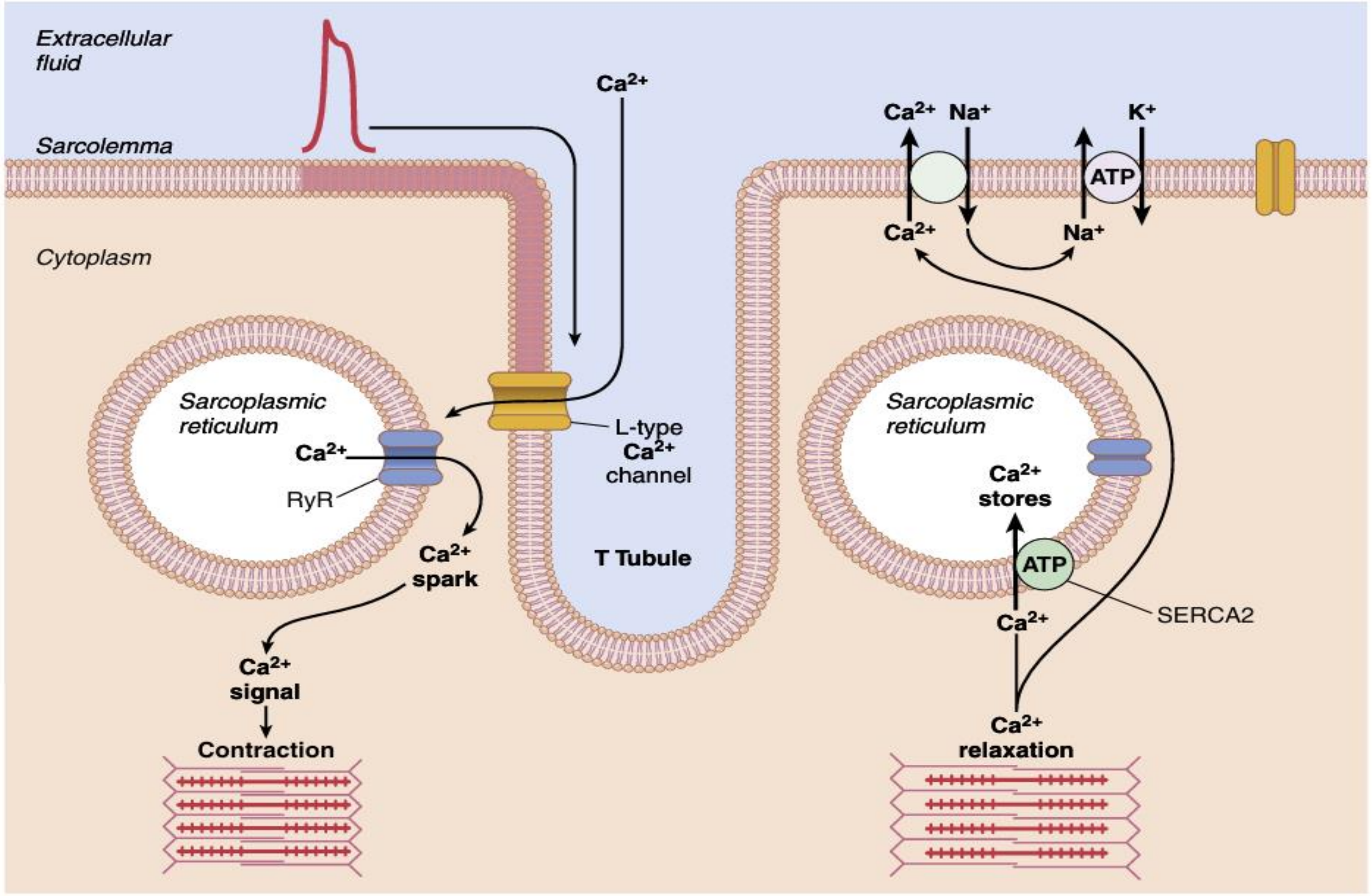
Physiology of Excitable Cells



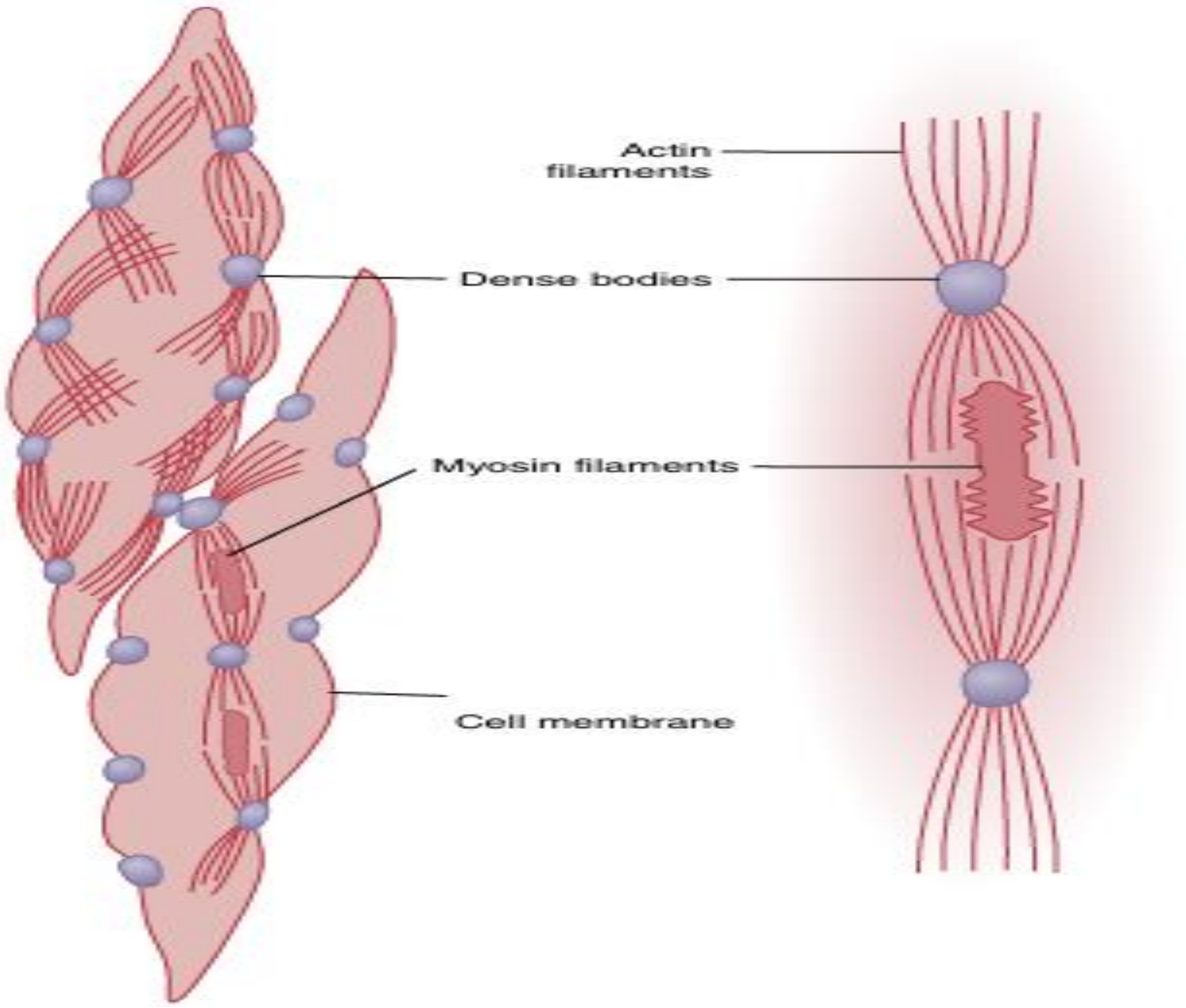
Physiology of Excitable Cells



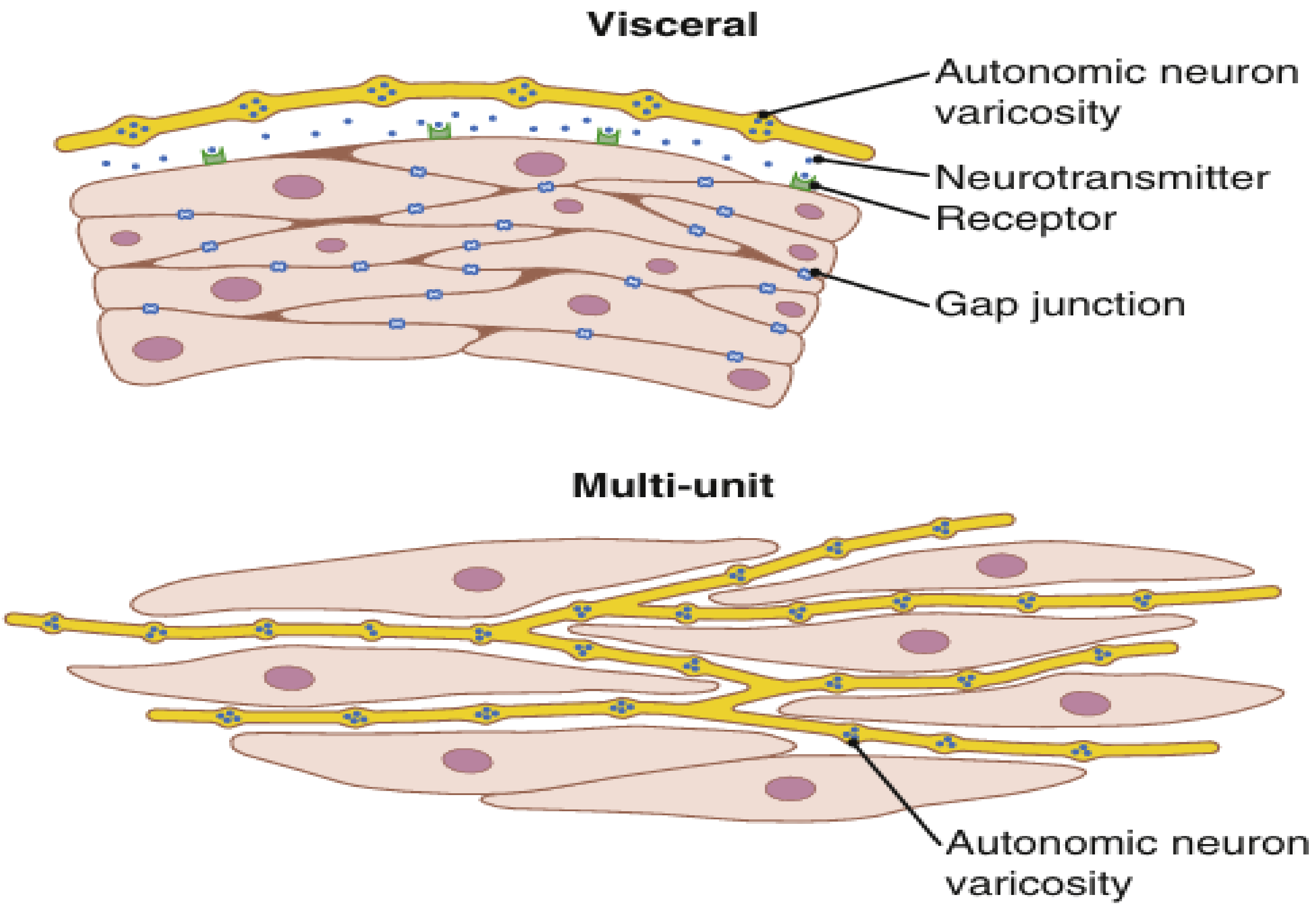
Physiology of Excitable Cells



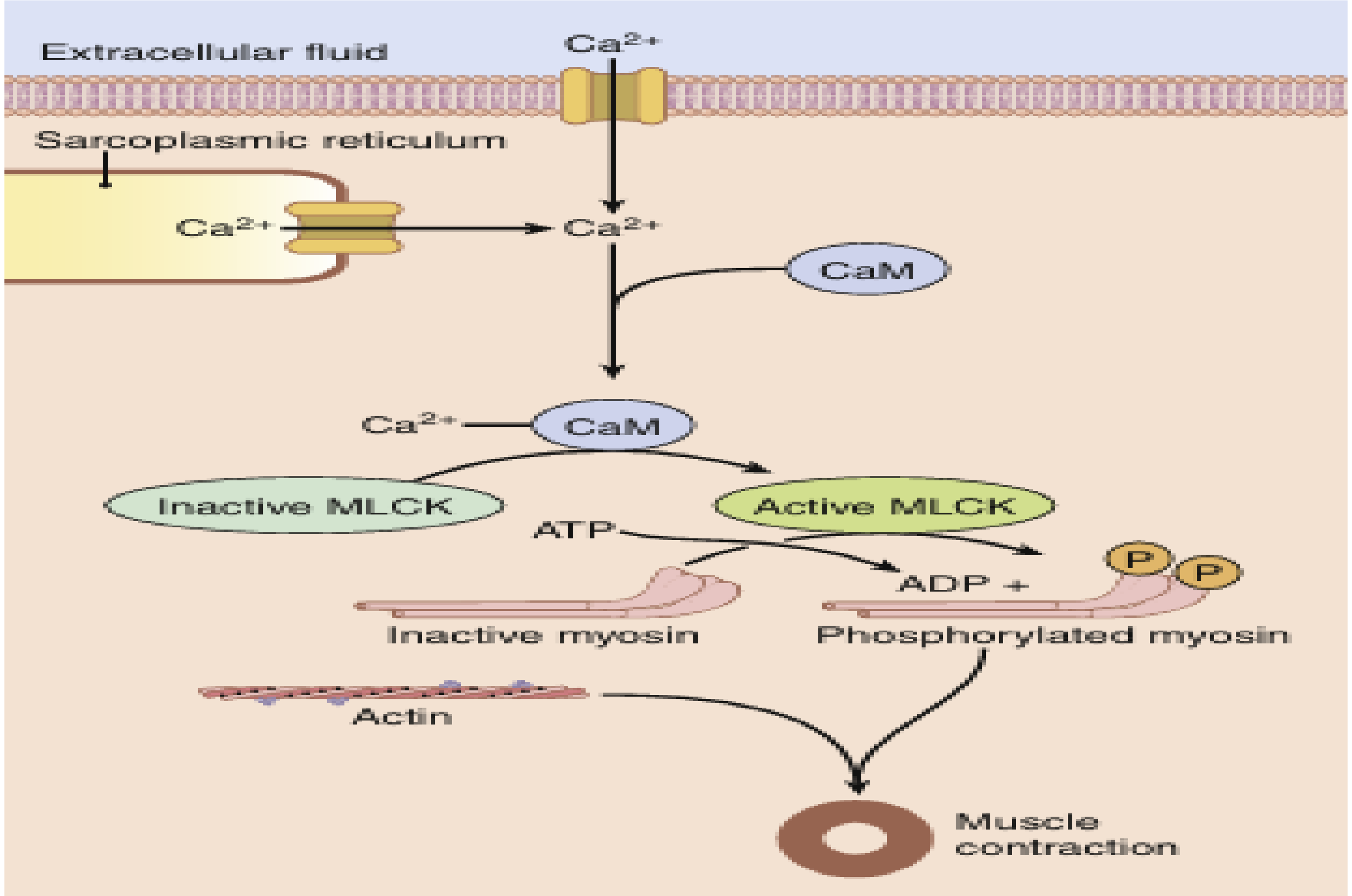
Physiology of Excitable Cells



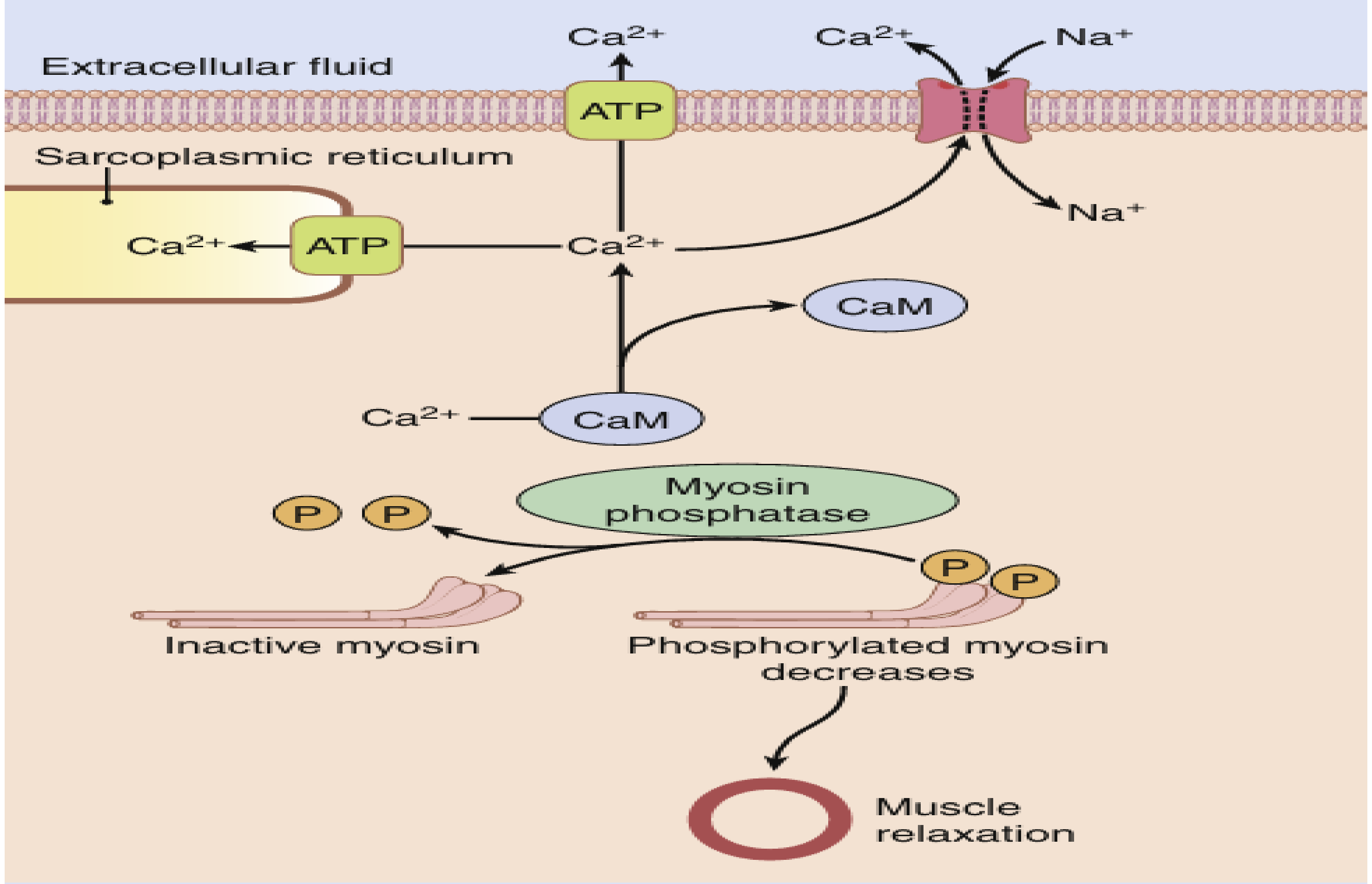
Physiology of Excitable Cells



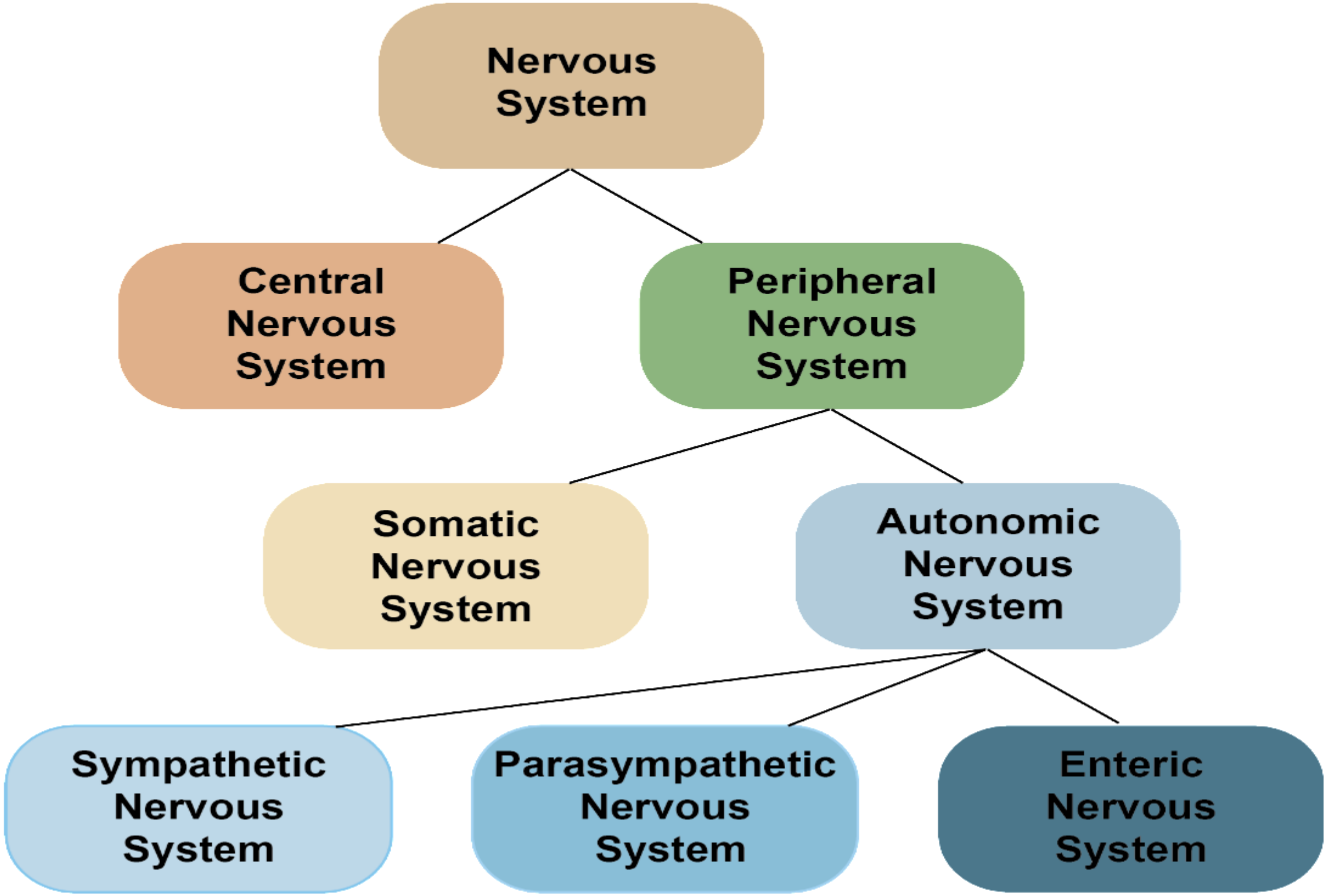
Physiology of Excitable Cells



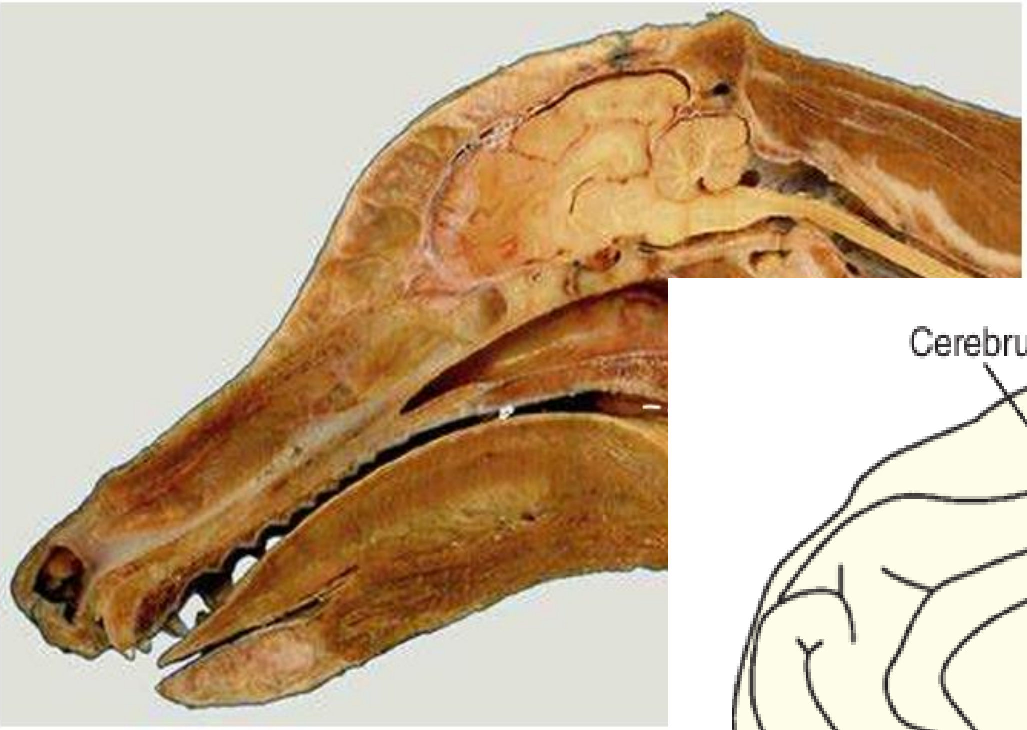
Physiology of Excitable Cells

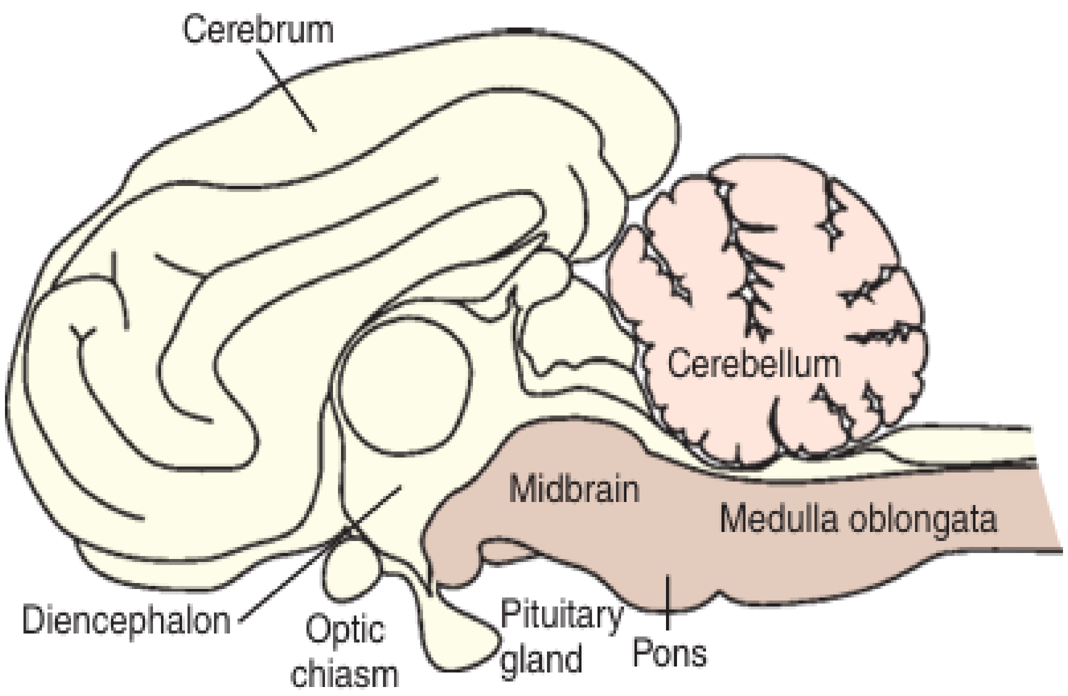


Neurophysiology

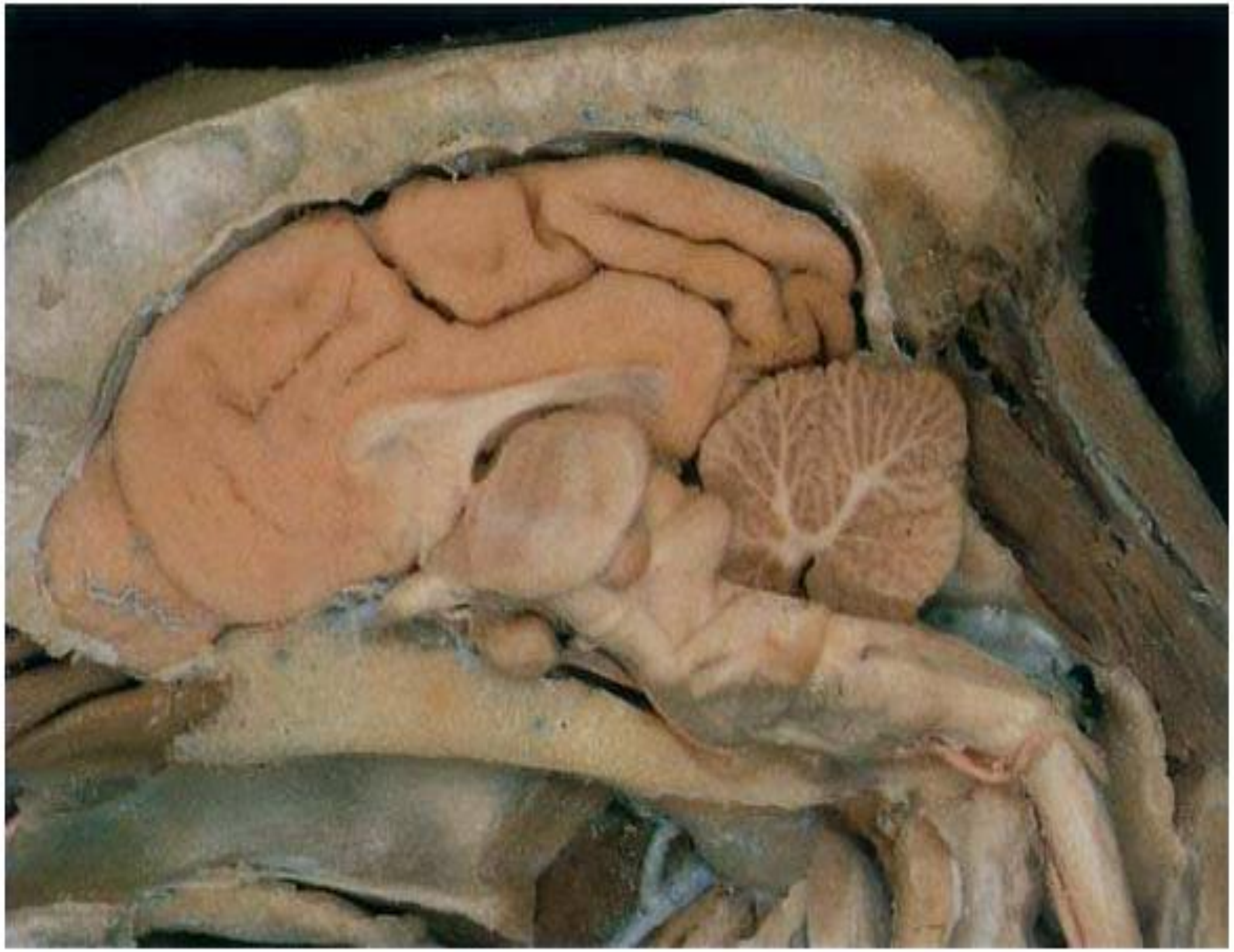


Neurophysiology





Neurophysiology



Neurophysiology

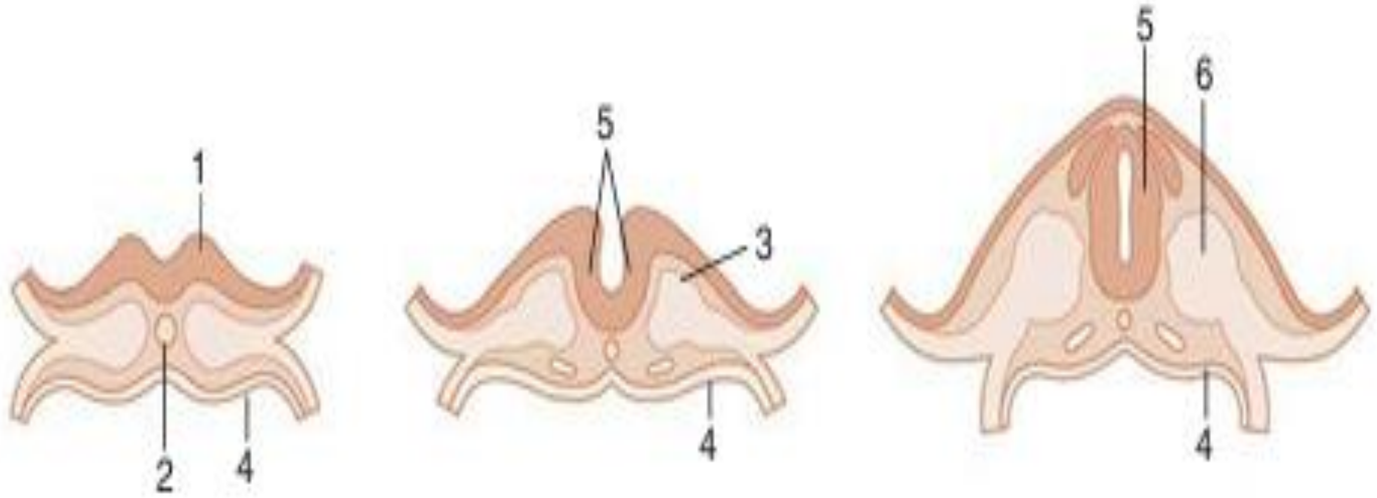


Fig. 8.9 *Left to right*, Three stages in the closure of the neural plate. *1*, Neural plate; *2*, notochord; *3*, paraxial mesoderm; *4*, endoderm; *5*, neural tube; *6*, somite.

Neurophysiology

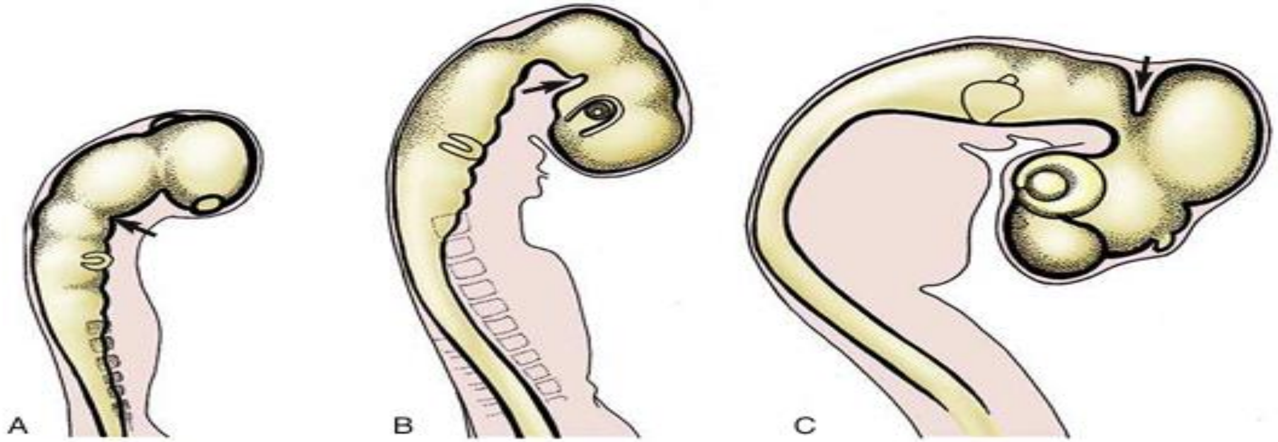
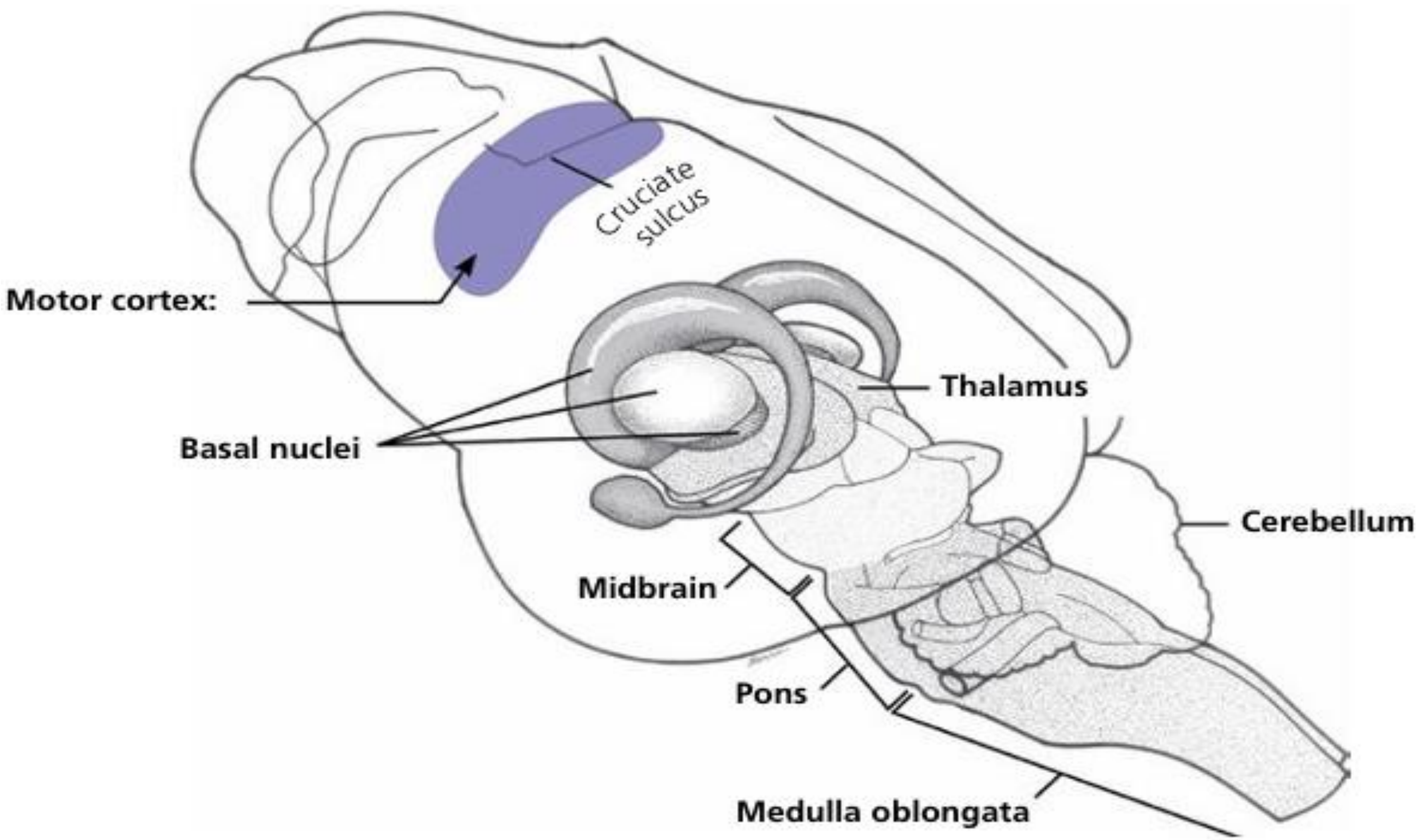


Fig. 8.14 Formation of the (A) caudal ventral, (B) rostral ventral, and (C) dorsal flexures *(arrows)*.

TABLE 8.1 DERIVATIVES OF THE NEURAL TUBE

Primary Division	Subdivisions	Major Derivatives	Lumen
		Cerebral cortex	Lateral ventricles (paired)
		Basal nuclei	
	Telencephalon		
		Limbic system	
Prosencephalon			
		Epithalamus	
	Diencephalon	Thalamus	Third ventricle
		Hypothalamus	
		Tectum (corpora quadrigemina)	
Mesencephalon		Tegmentum	Mesencephalic aqueduct
		Cerebellum	
	Metencephalon		Rostral part of fourth ventricle
Rhombencephalon		Pons	
	Myelencephalon	Medulla oblongata	Caudal part of fourth ventricle
Remainder of neural tube		Spinal cord	Central canal

Neurophysiology



Neurophysiology

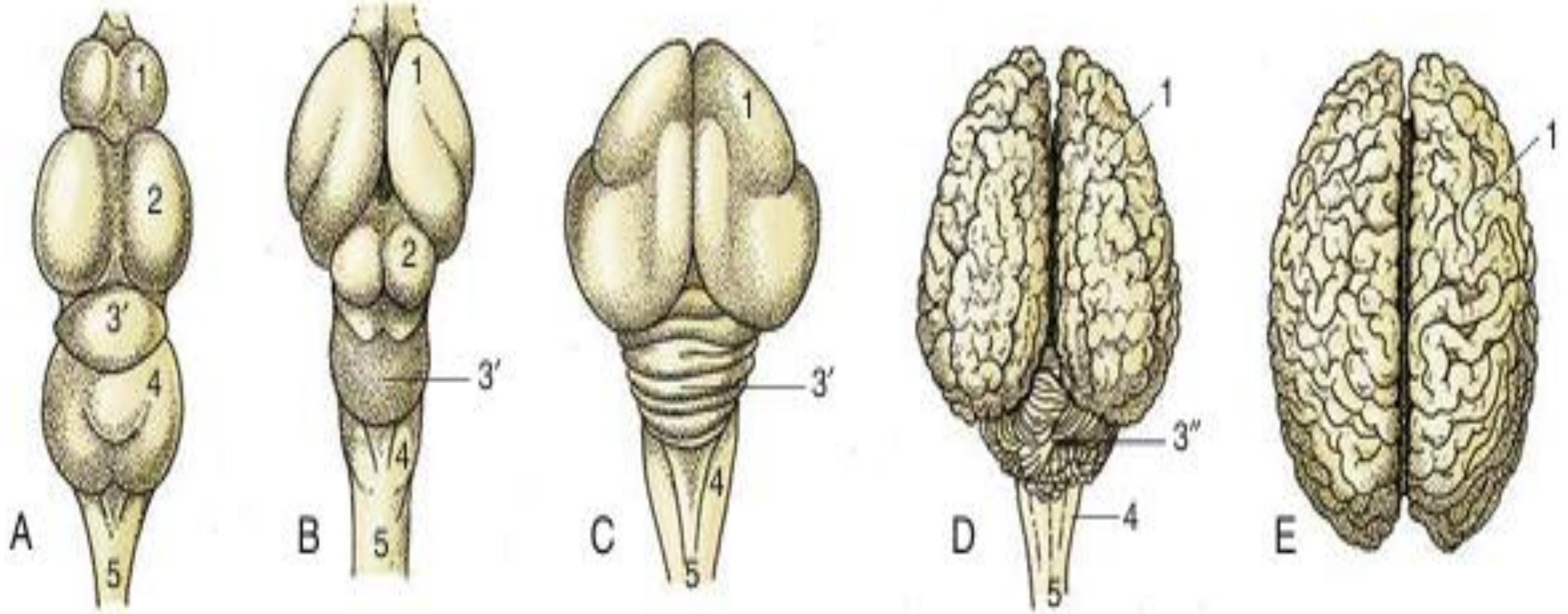
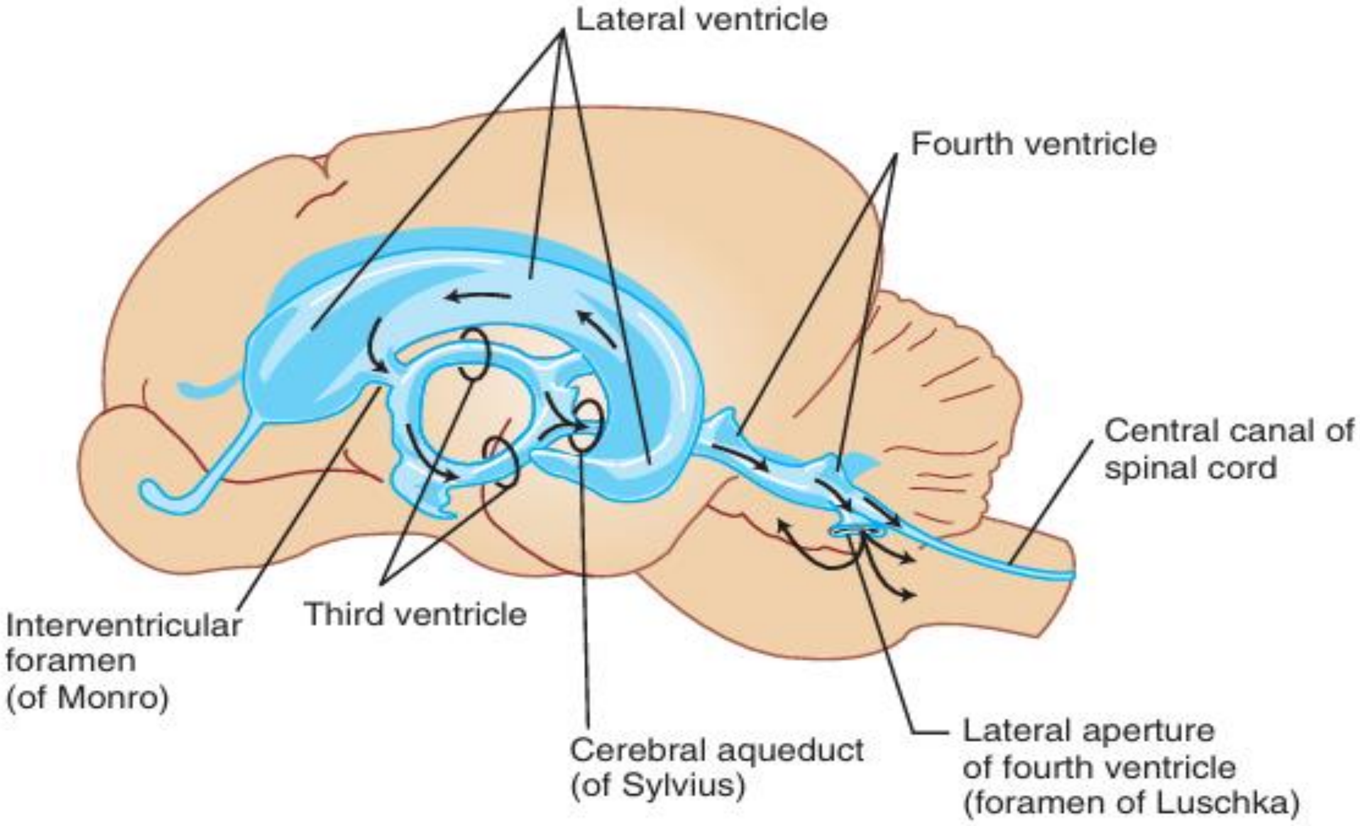
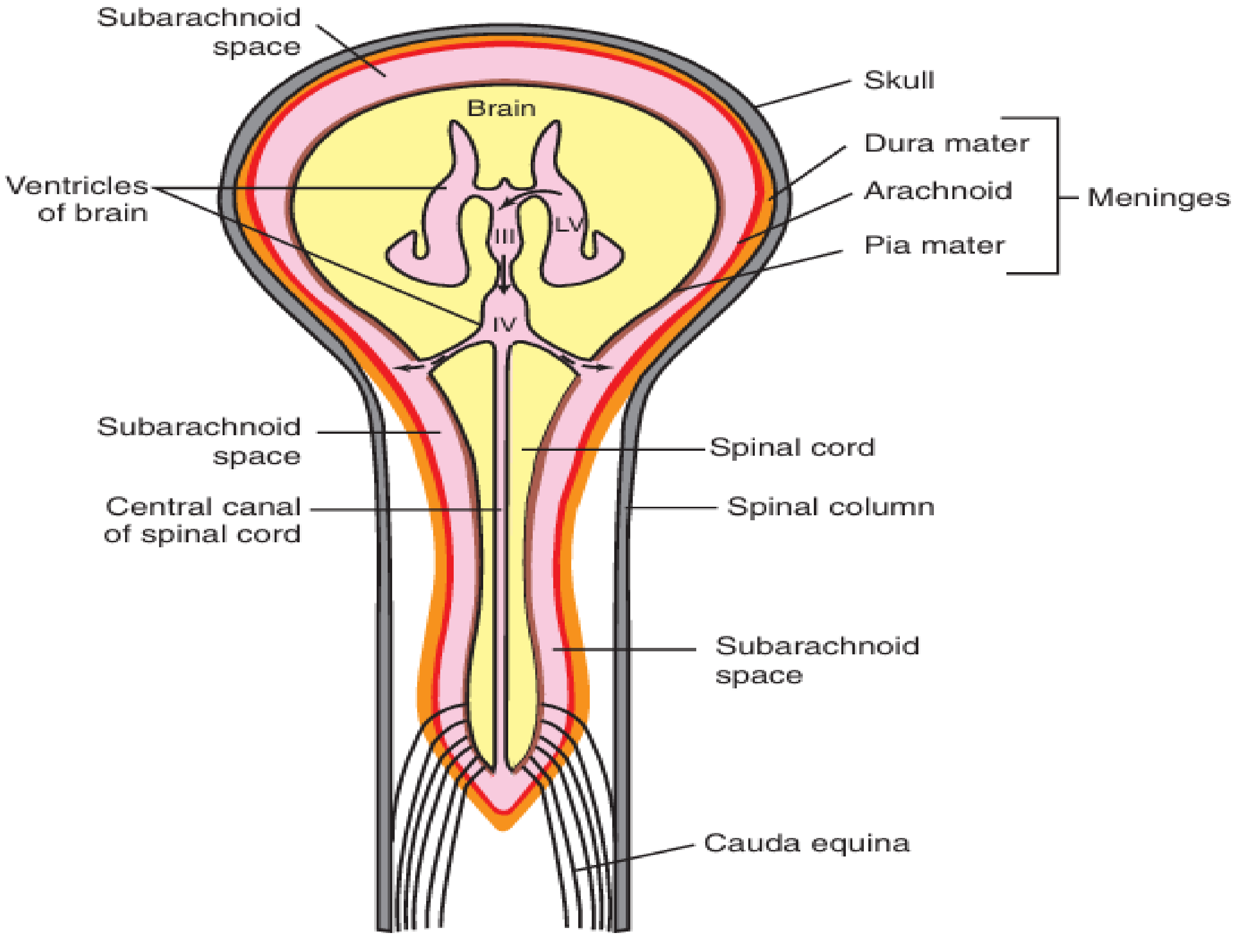


Fig. 8.8 Vertebrate brains illustrating the phylogenetic development. The increase in volume and complexity of the telencephalon and cerebellum is most striking. (A) Fish (carp); (B) reptile (python); (C) bird (duck); (D) mammal (cattle); (E) mammal (human). *1*, Telencephalon; *2*, mesencephalon; *3′ and 3″*, metencephalon *(3′* archicerebellum in *A-C; 3″* neocerebellum in D*)*; myelencephalon; *5*, spinal cord.

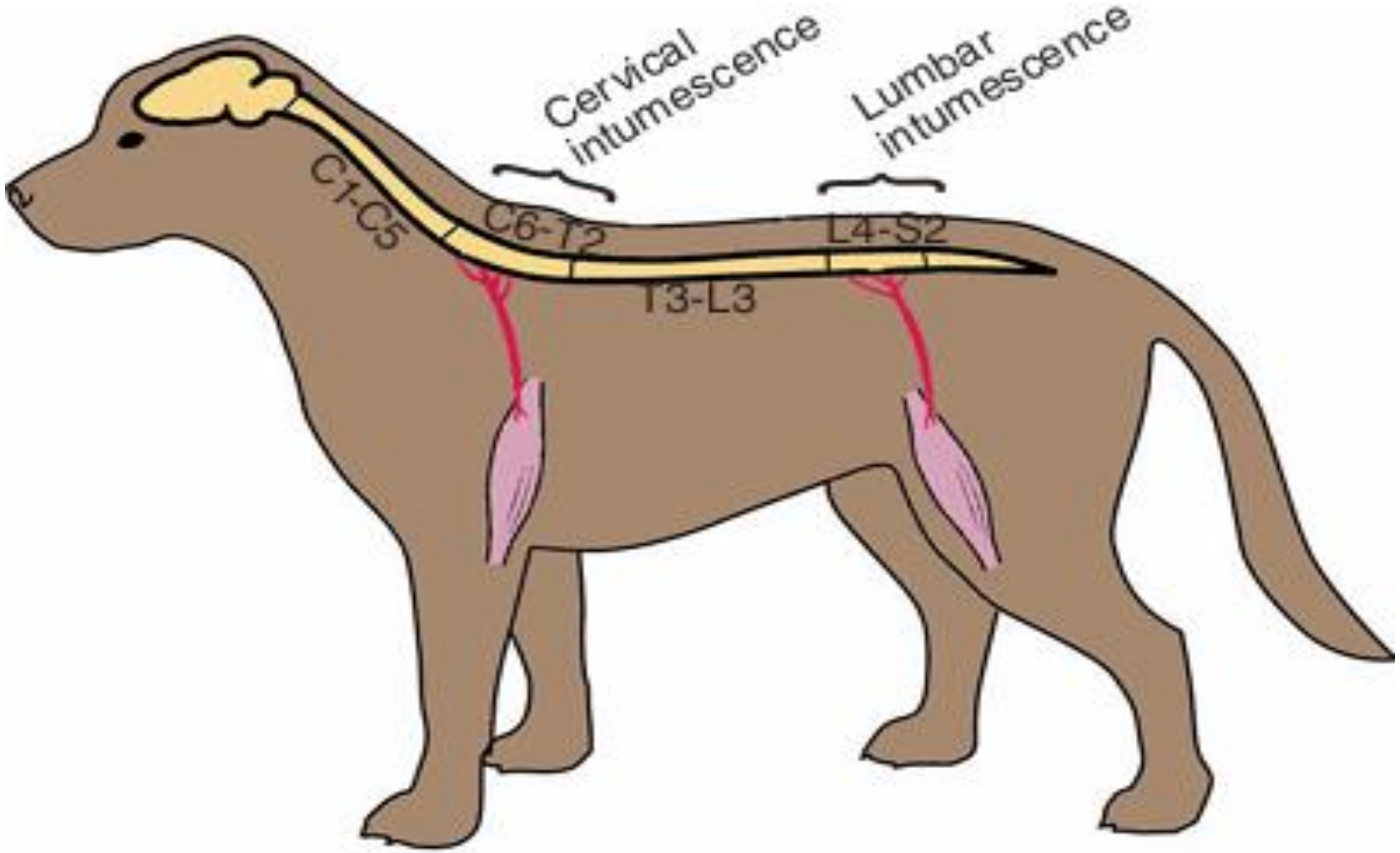
Neurophysiology



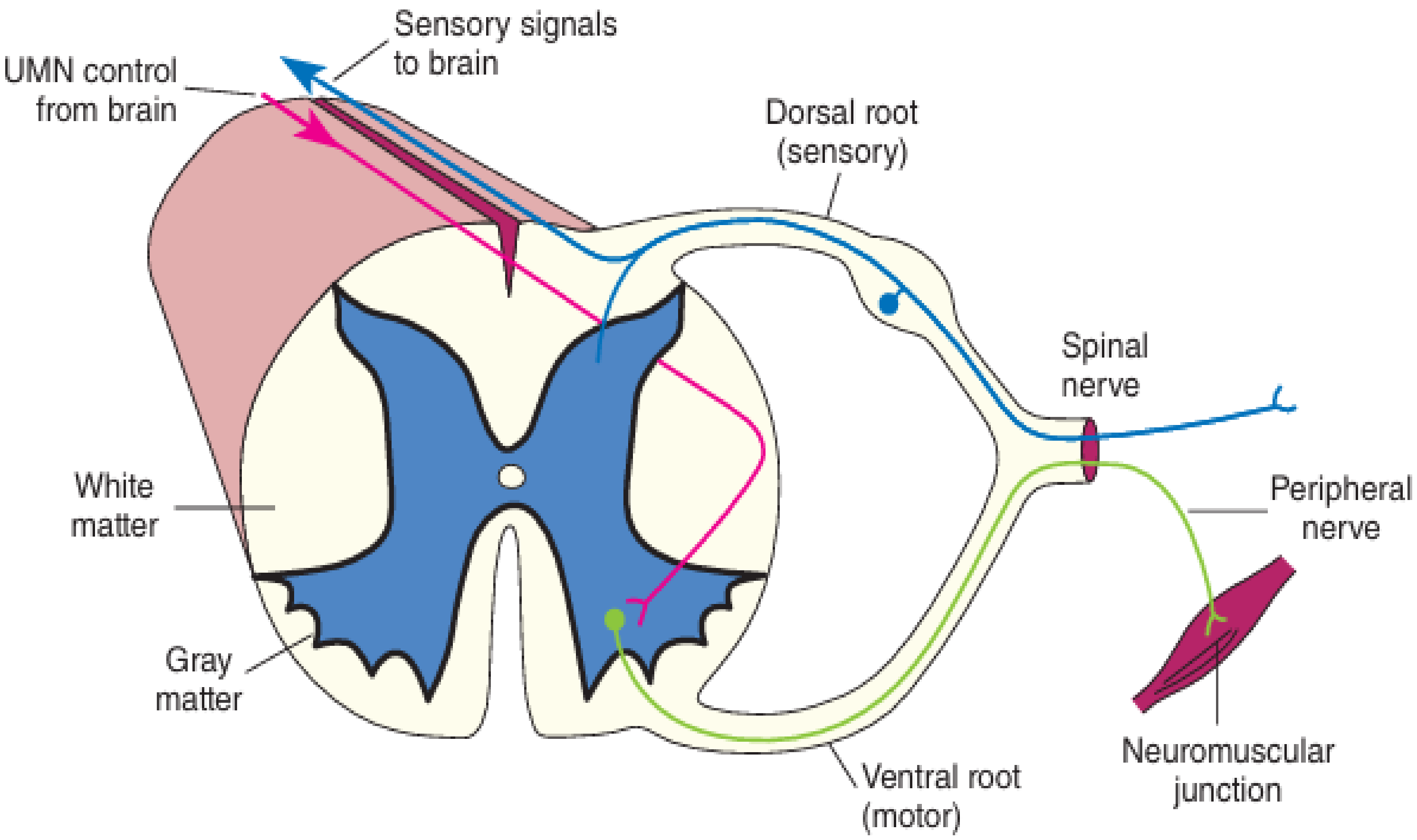
Neurophysiology



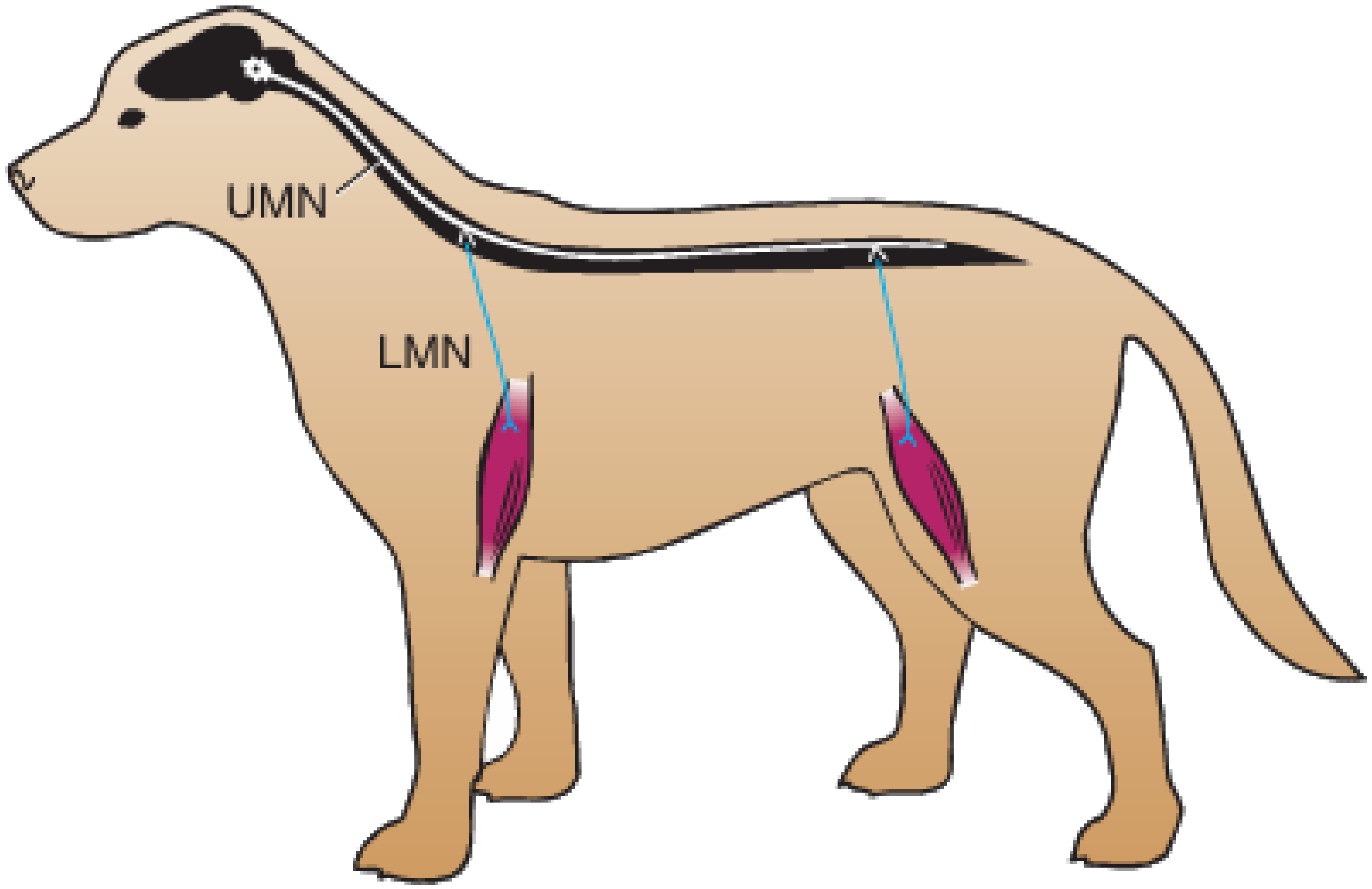
Neurophysiology



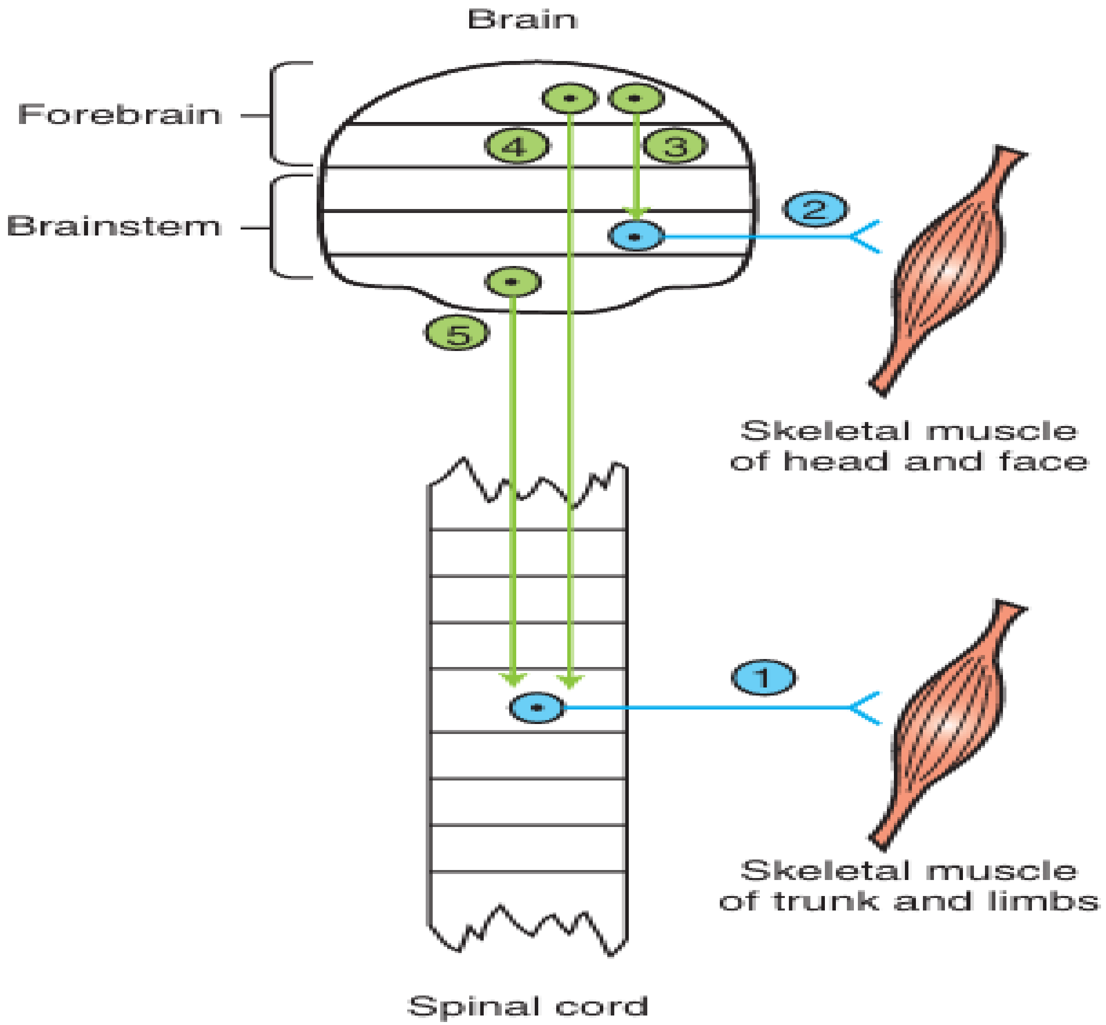
Neurophysiology



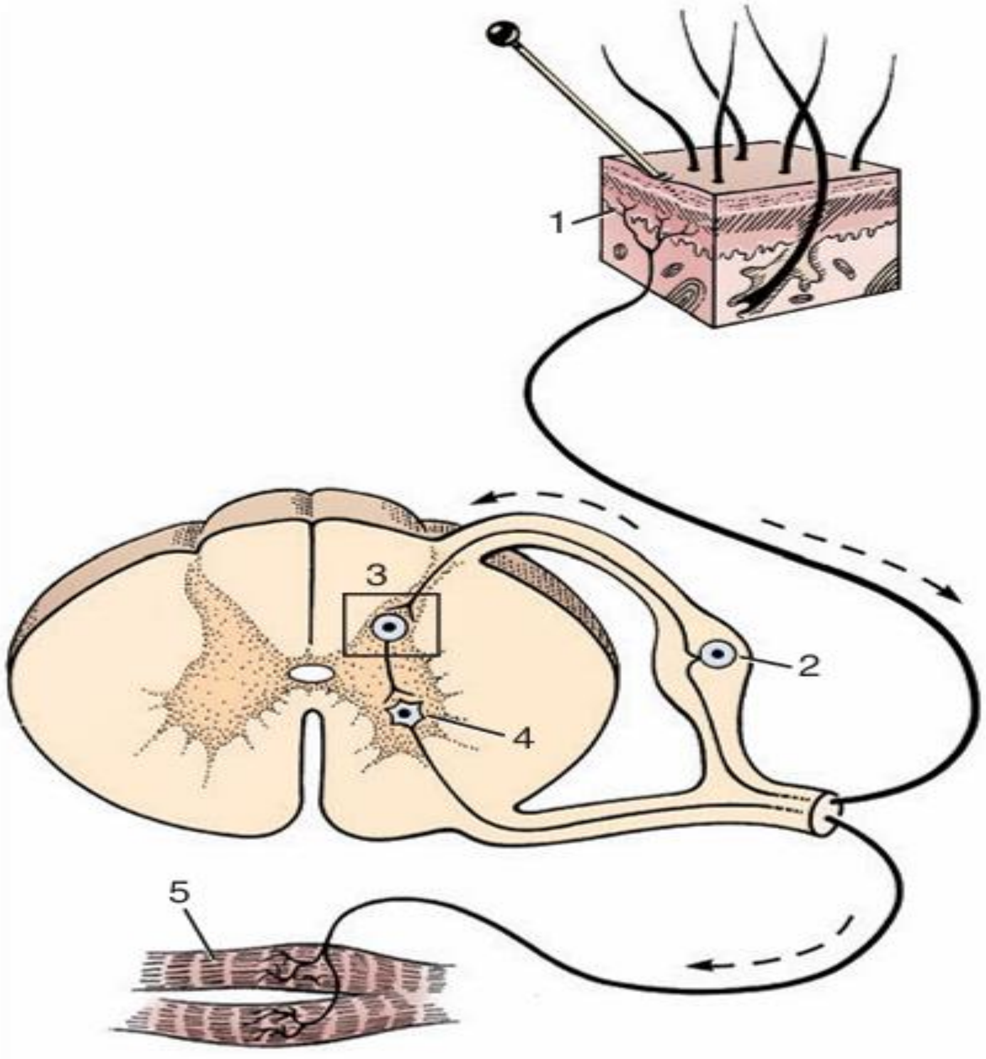
Neurophysiology



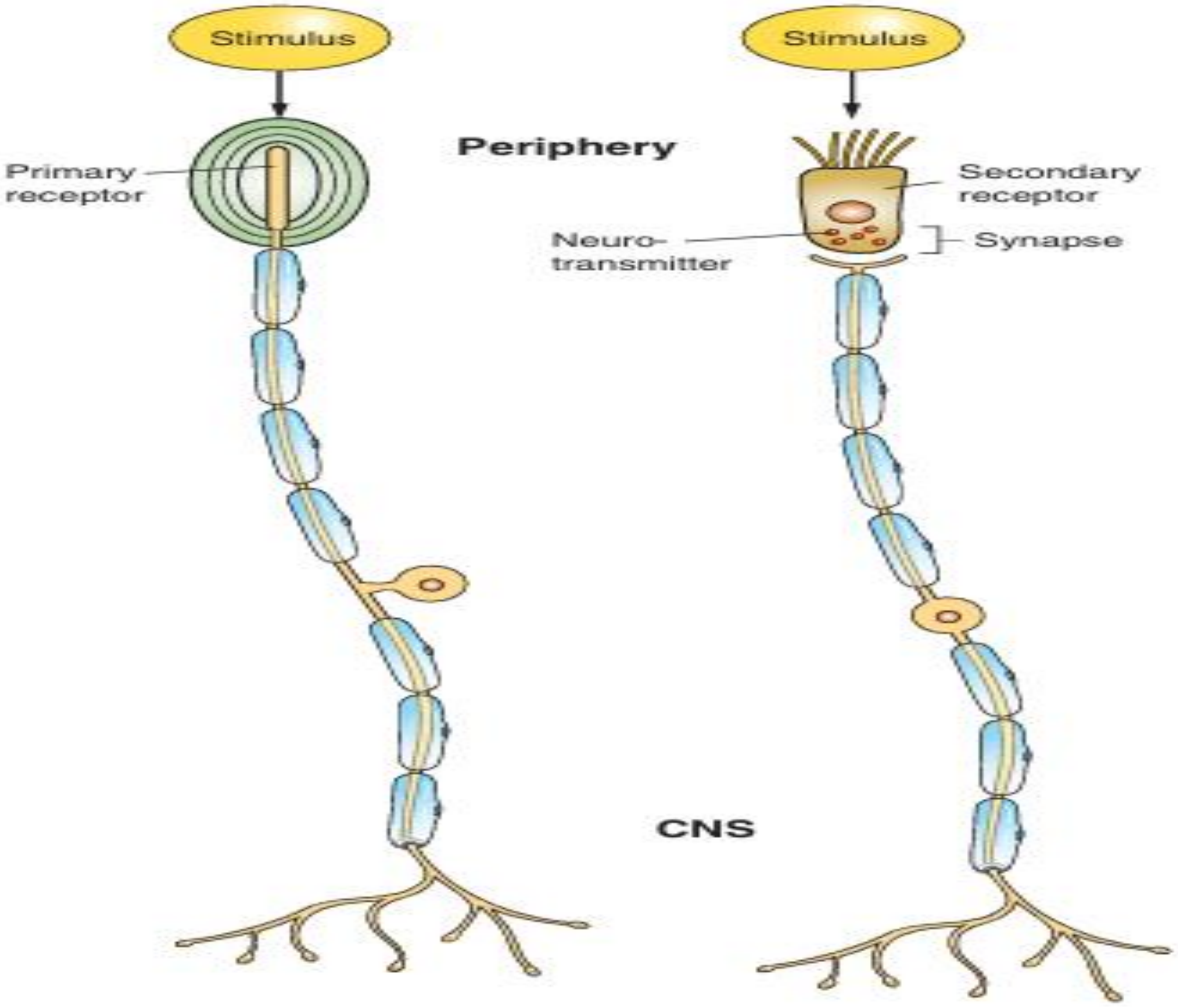
Neurophysiology



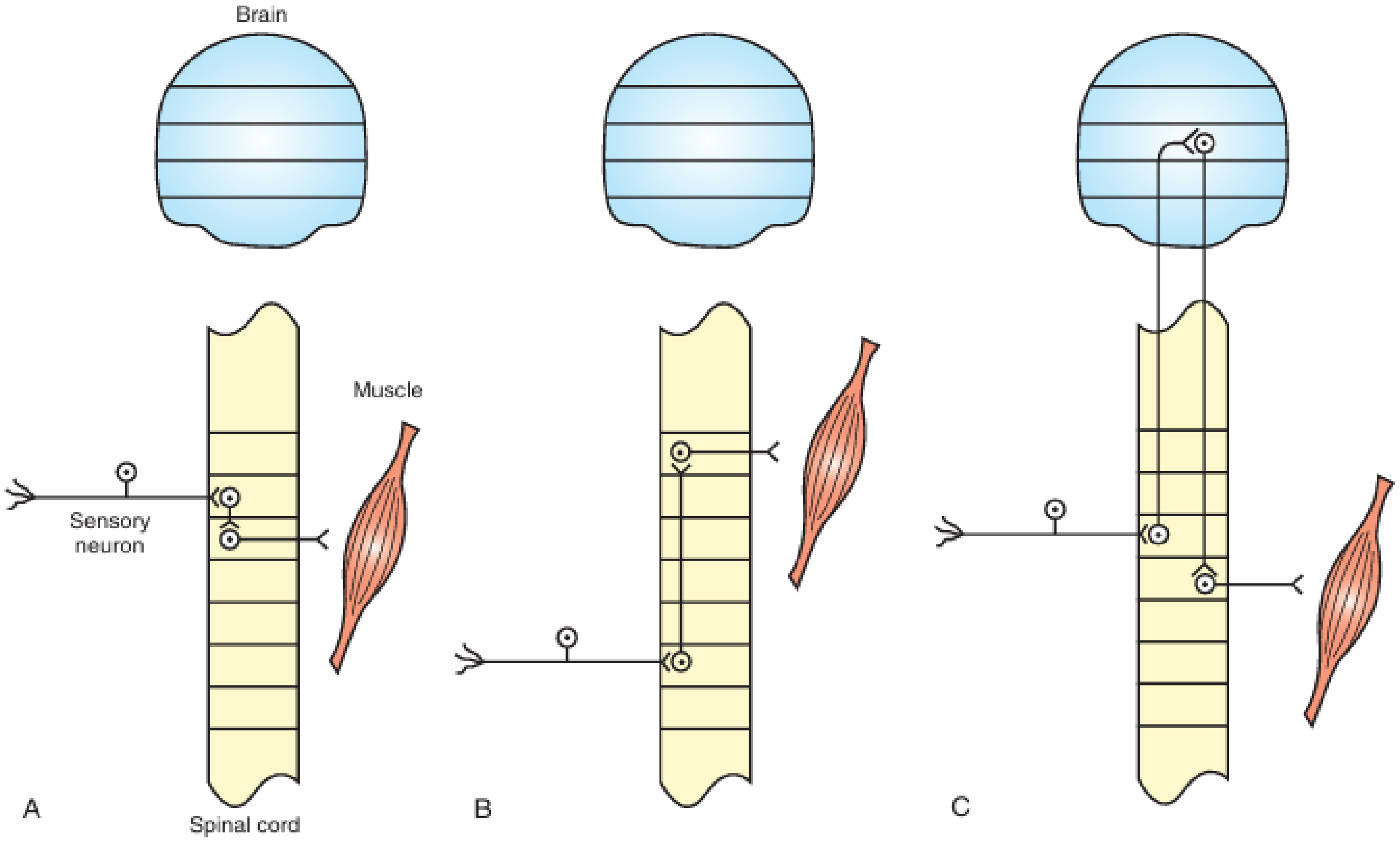
Neurophysiology



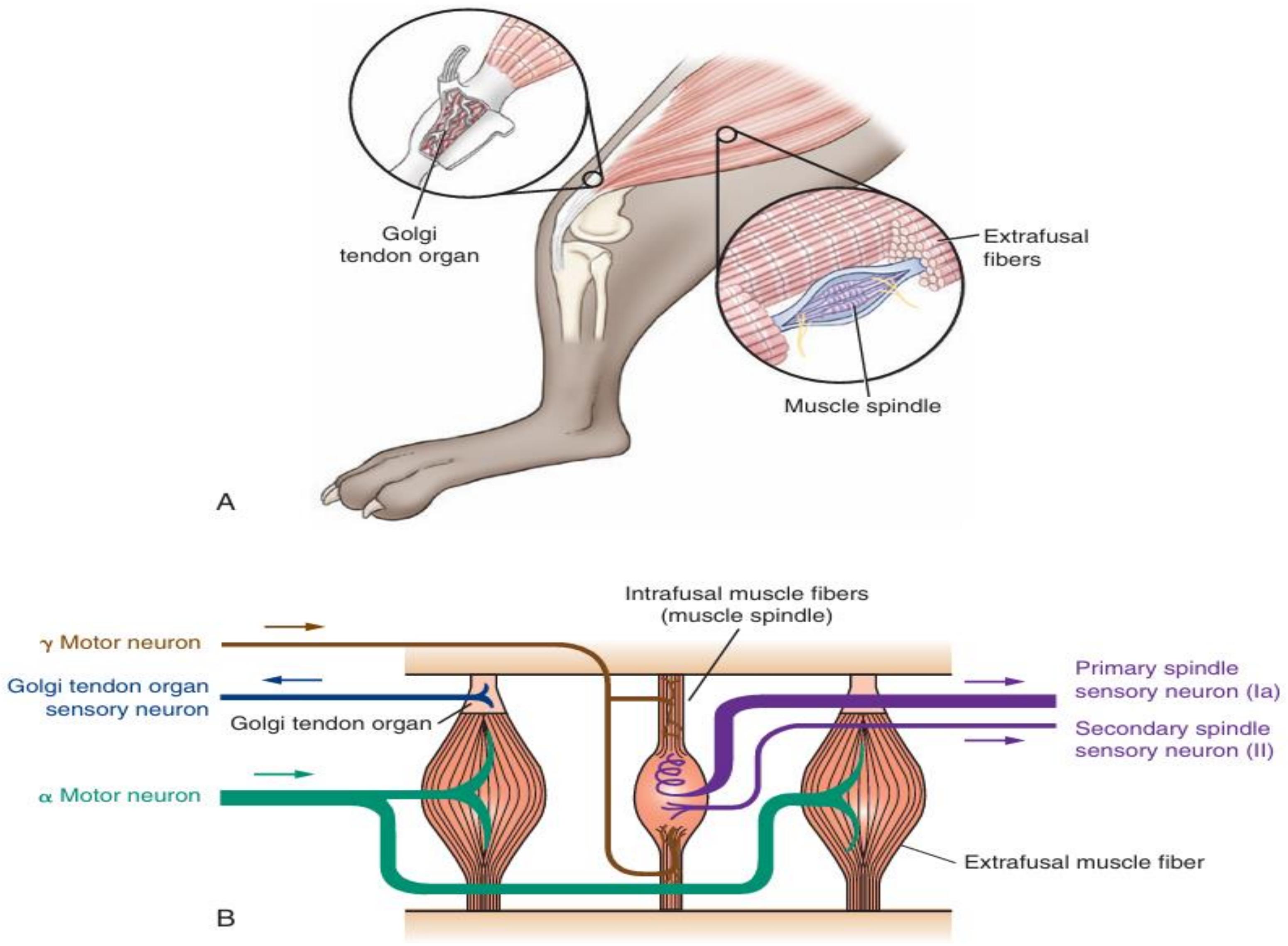
Neurophysiology



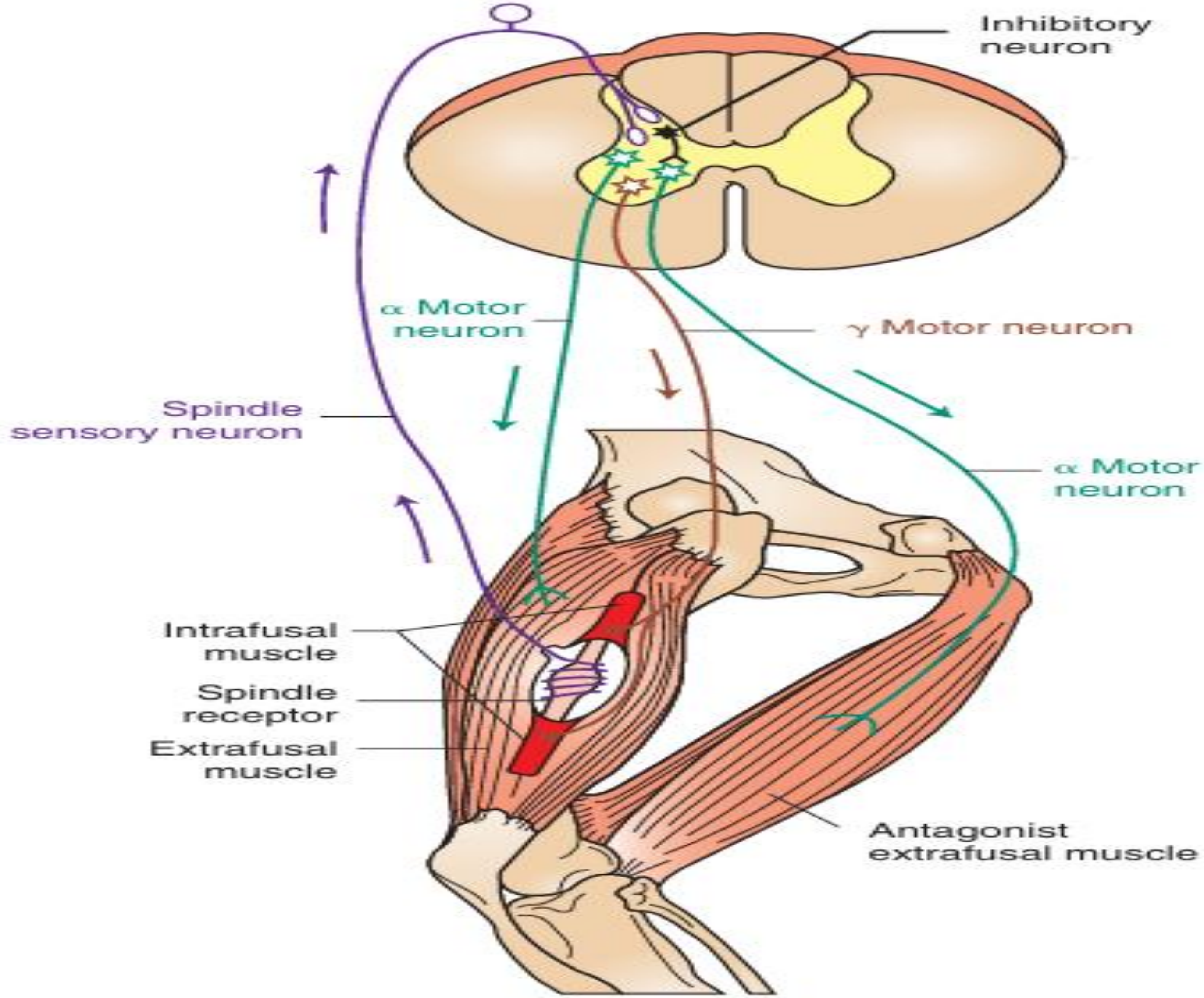
Neurophysiology



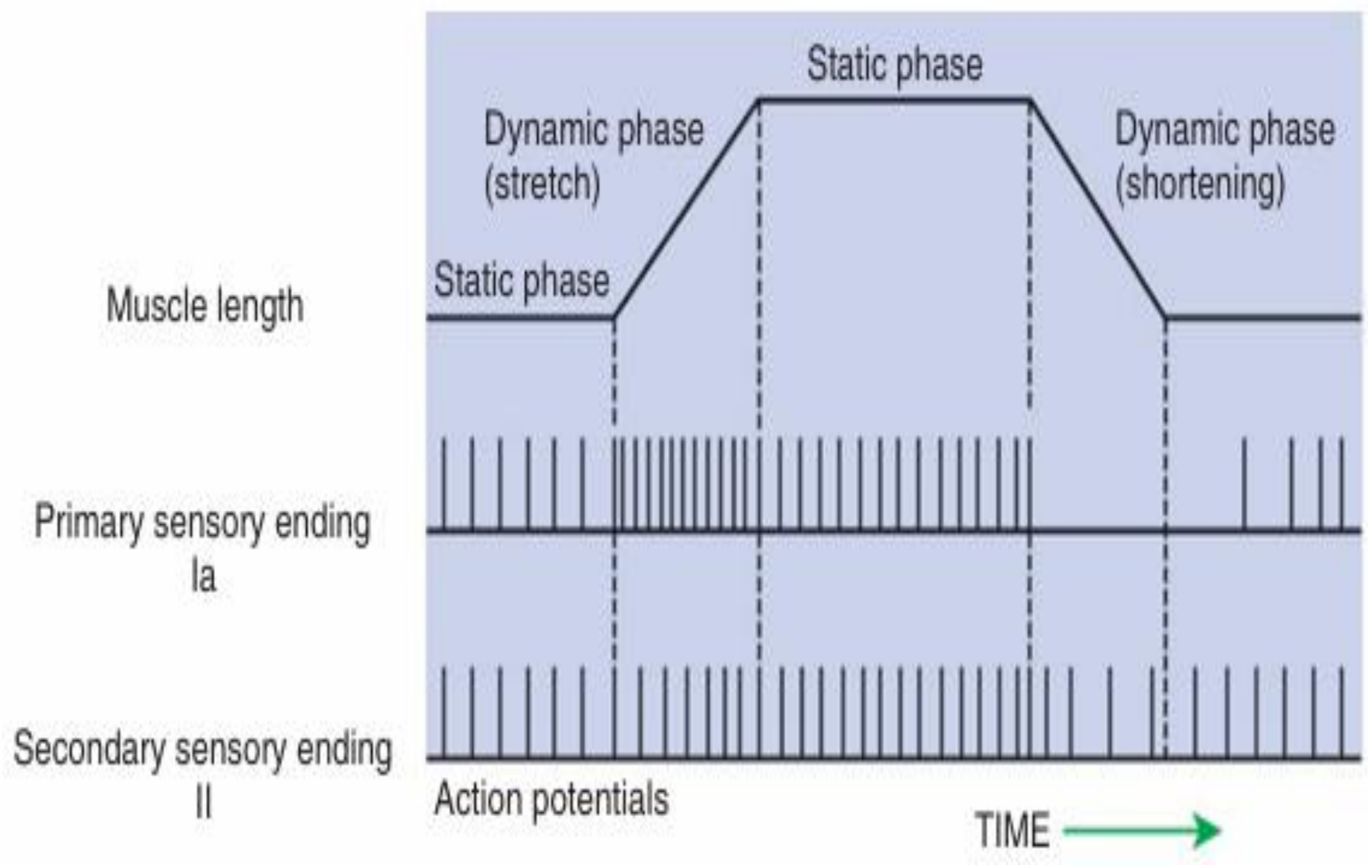
Neurophysiology



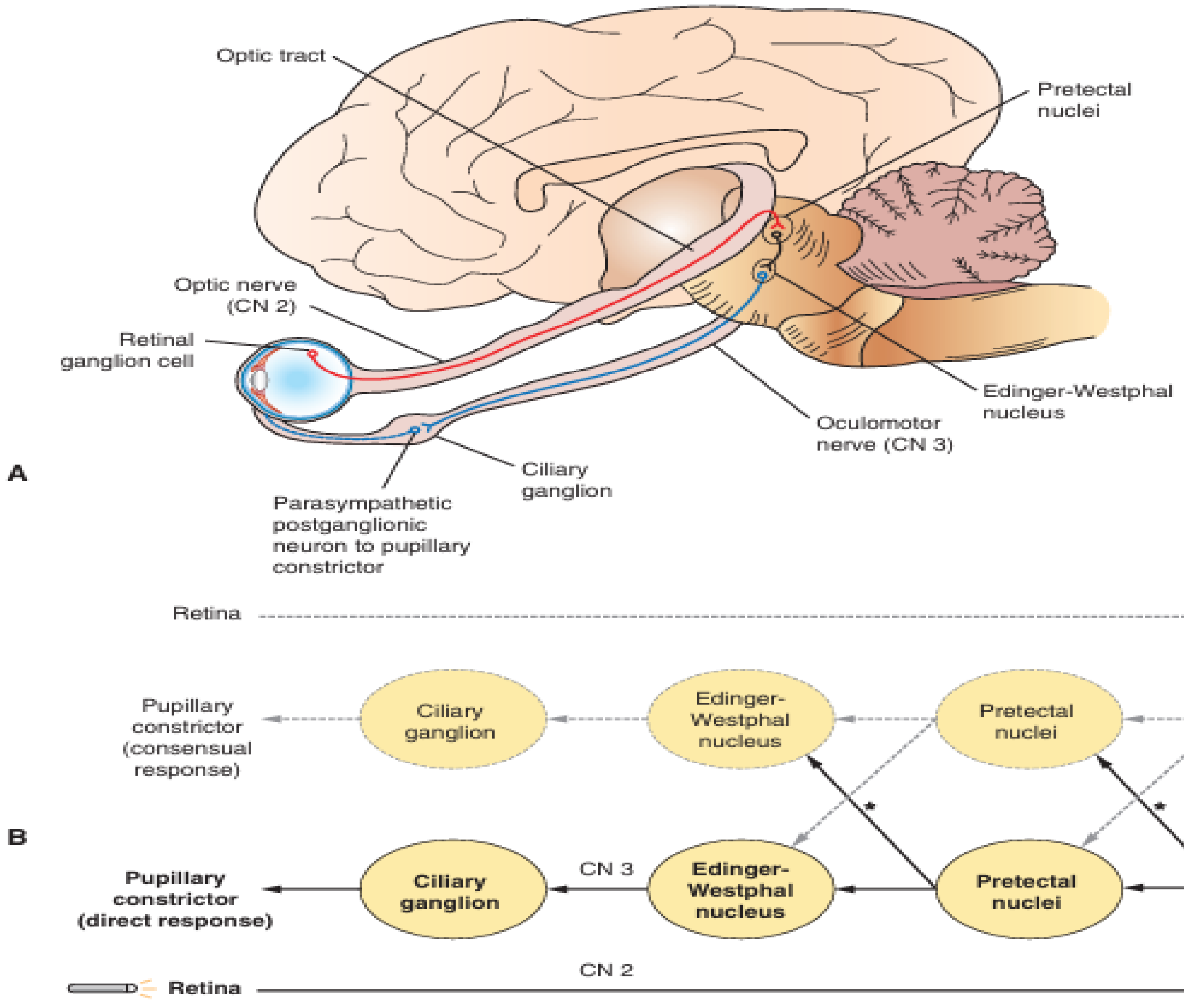
Neurophysiology



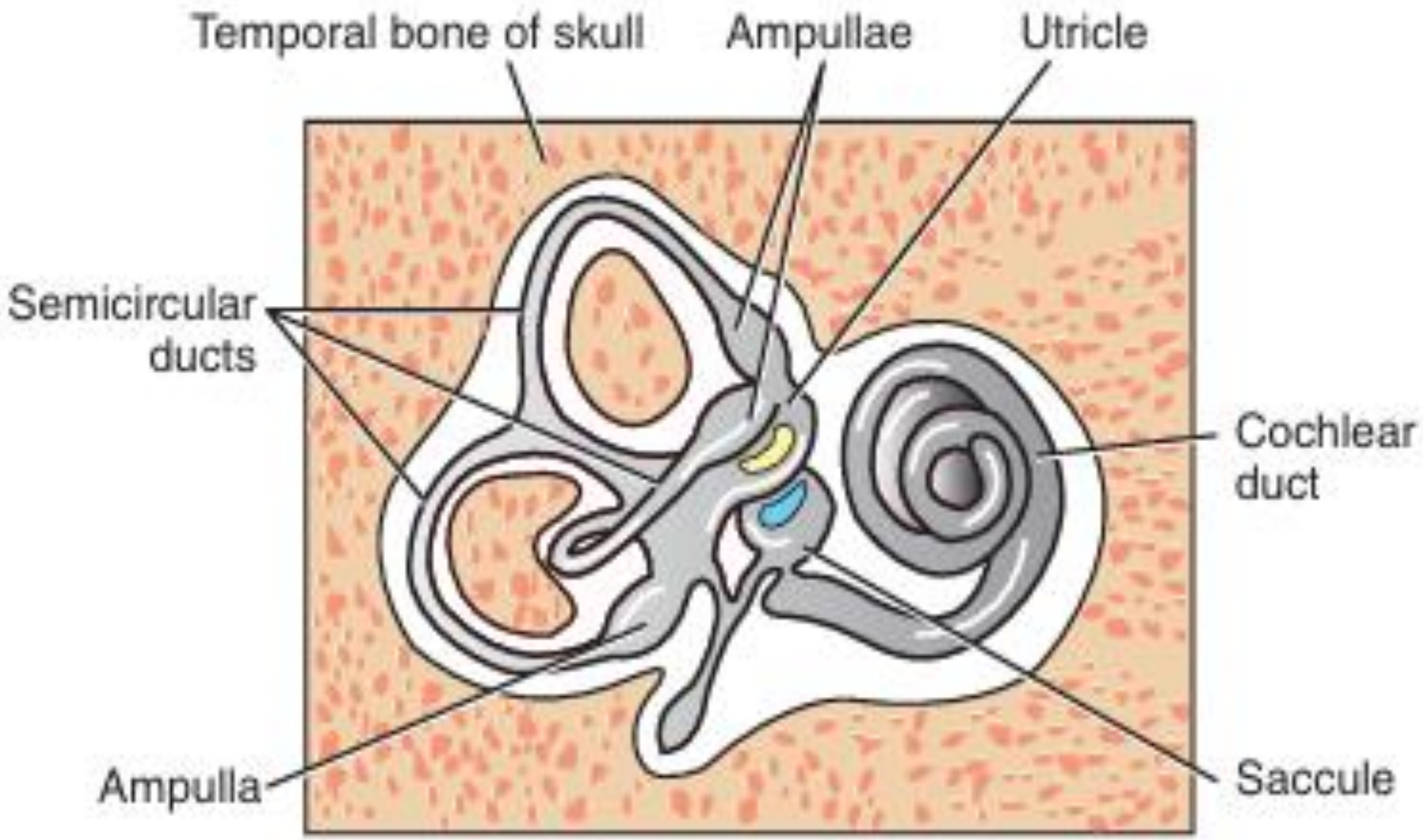
Neurophysiology



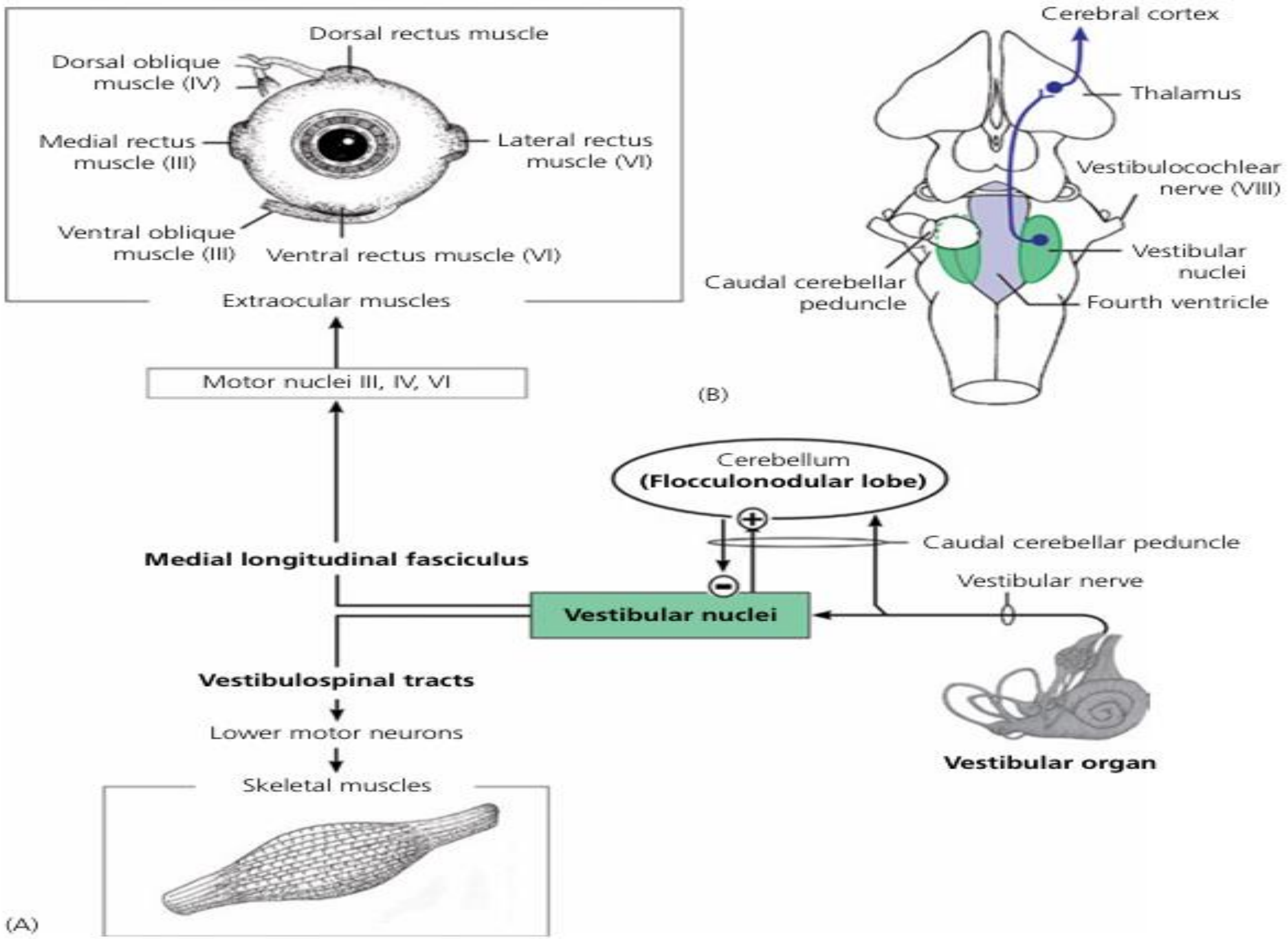
Neurophysiology



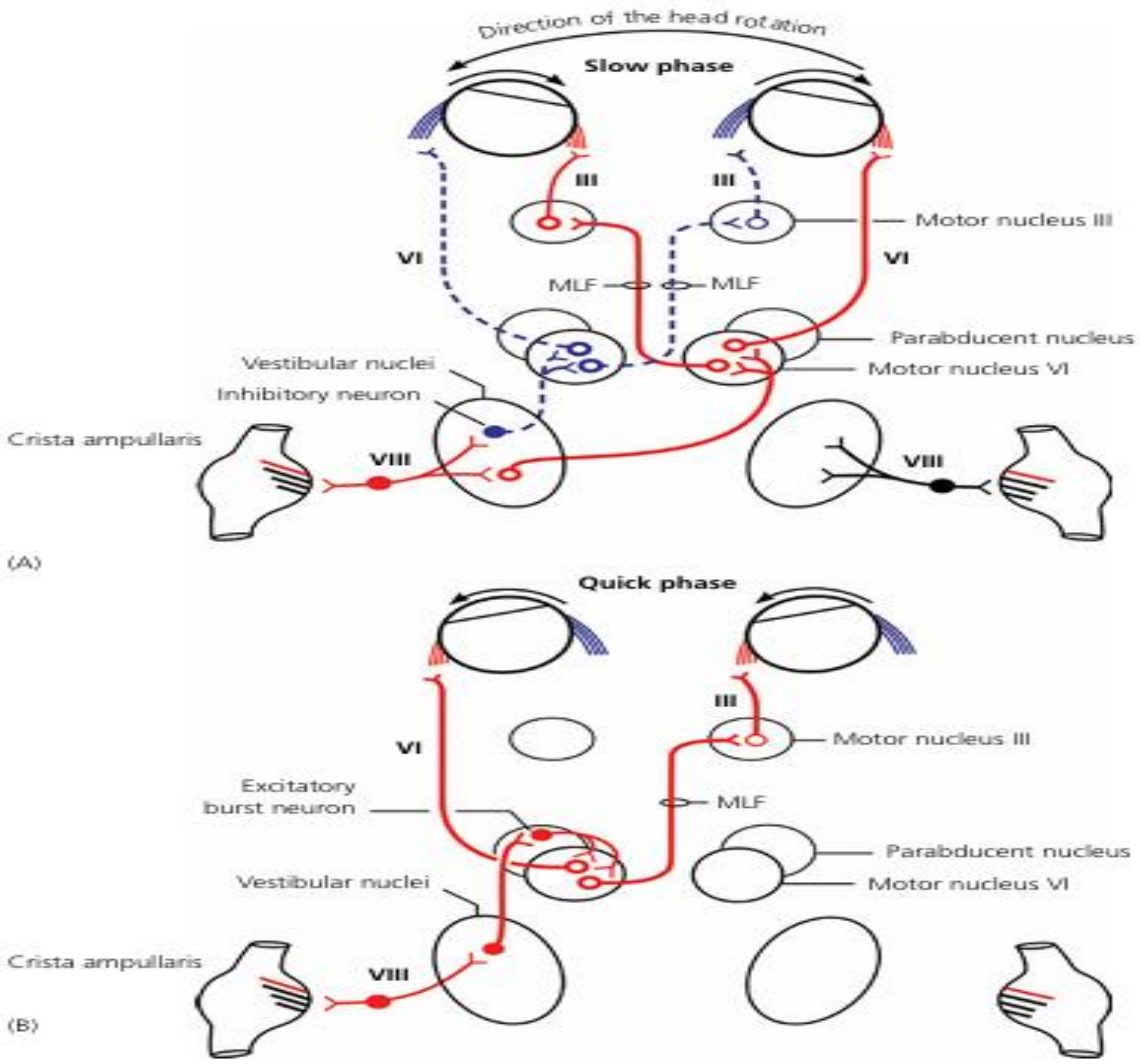
Neurophysiology



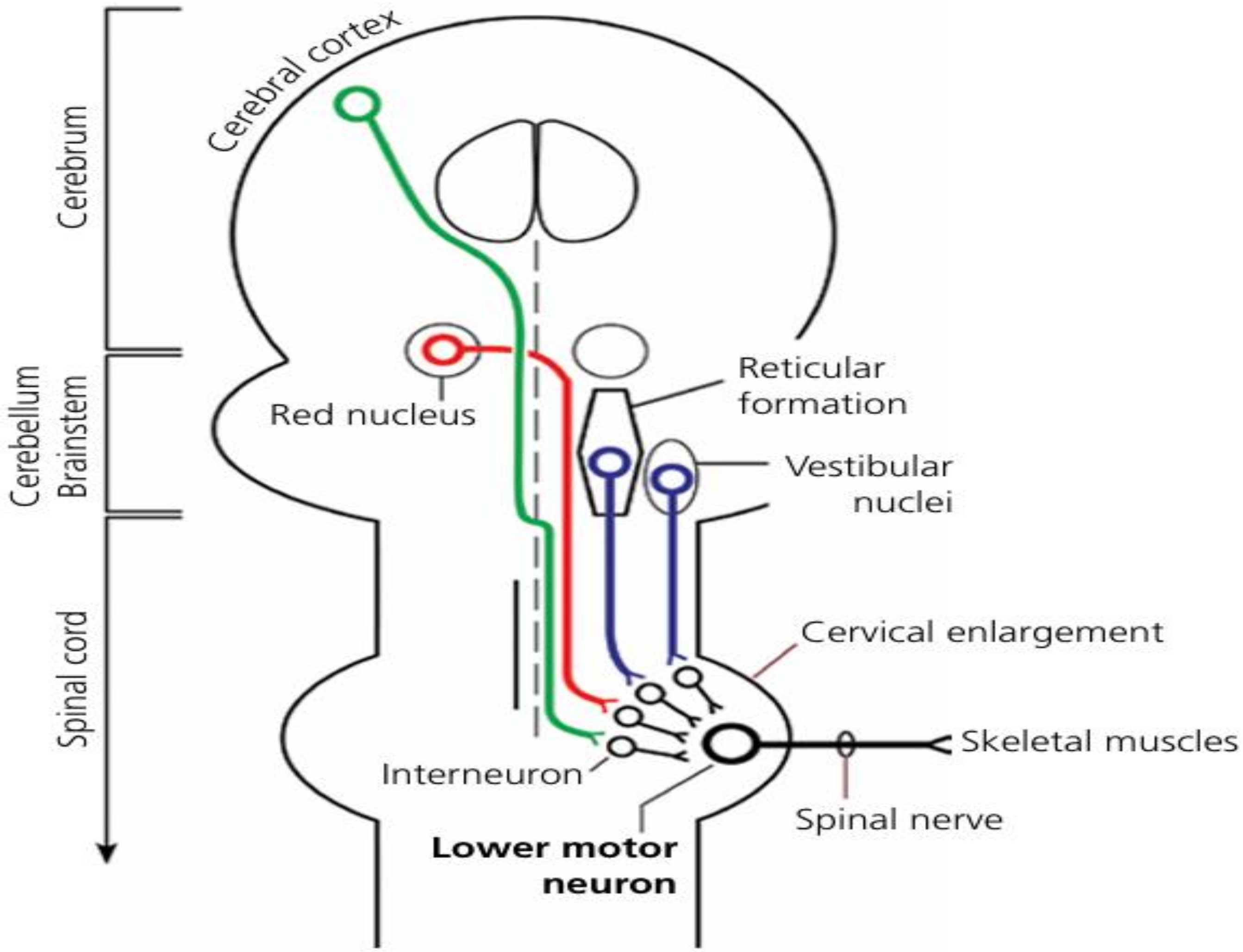
Neurophysiology



Neurophysiology



Neurophysiology



Neurophysiology

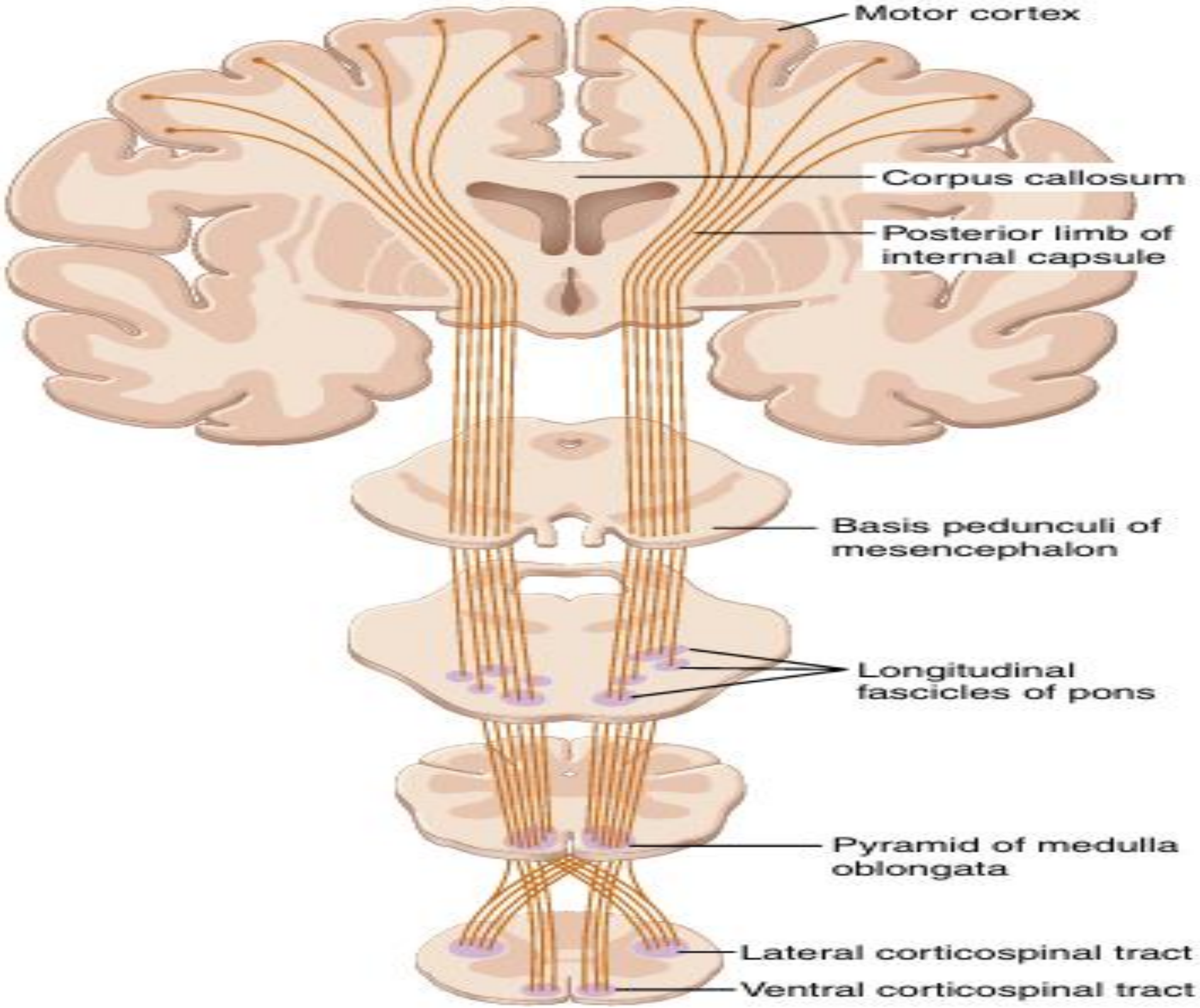
The Corticospinal (Pyramidal) Tract Is a Direct Projection From Cerebral Cortex to Spinal Cord Responsible for the Most Skilled Voluntary Movements of Mammals

The Rubrospinal Tract Is a Lateral Brainstem Motor Pathway That Can Control Distal Limb Musculature Associated With Skilled Movement

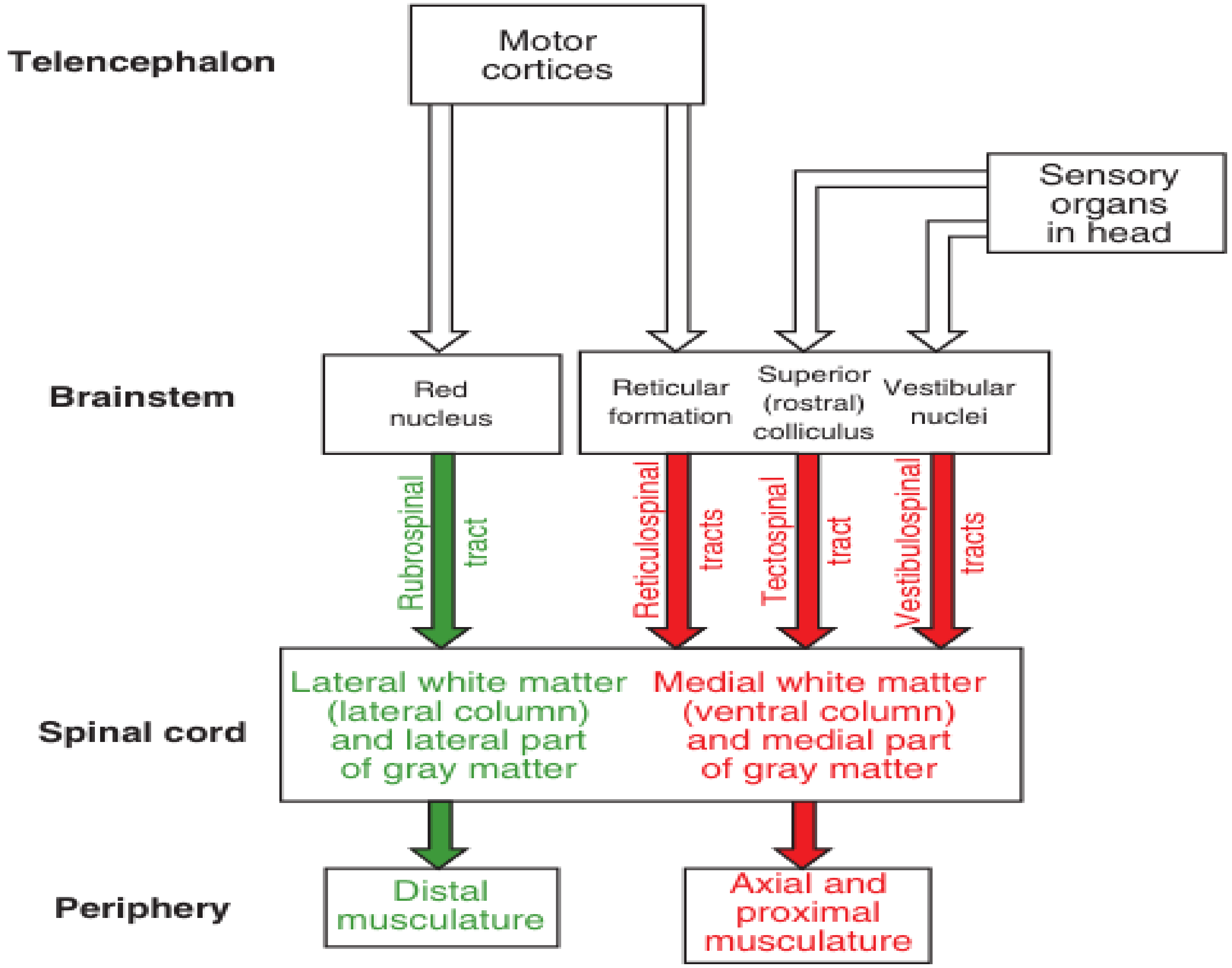
The Basal Ganglia and Cerebellum Modulate the Activity of Motor System Components for the Respective Selection and Adjustment of Movement

The Reticulospinal and Vestibulospinal Tracts Are Medial Brainstem Motor Pathways Important for Keeping the Body Upright Against the Pull of Gravity

Neurophysiology



Neurophysiology



Neurophysiology

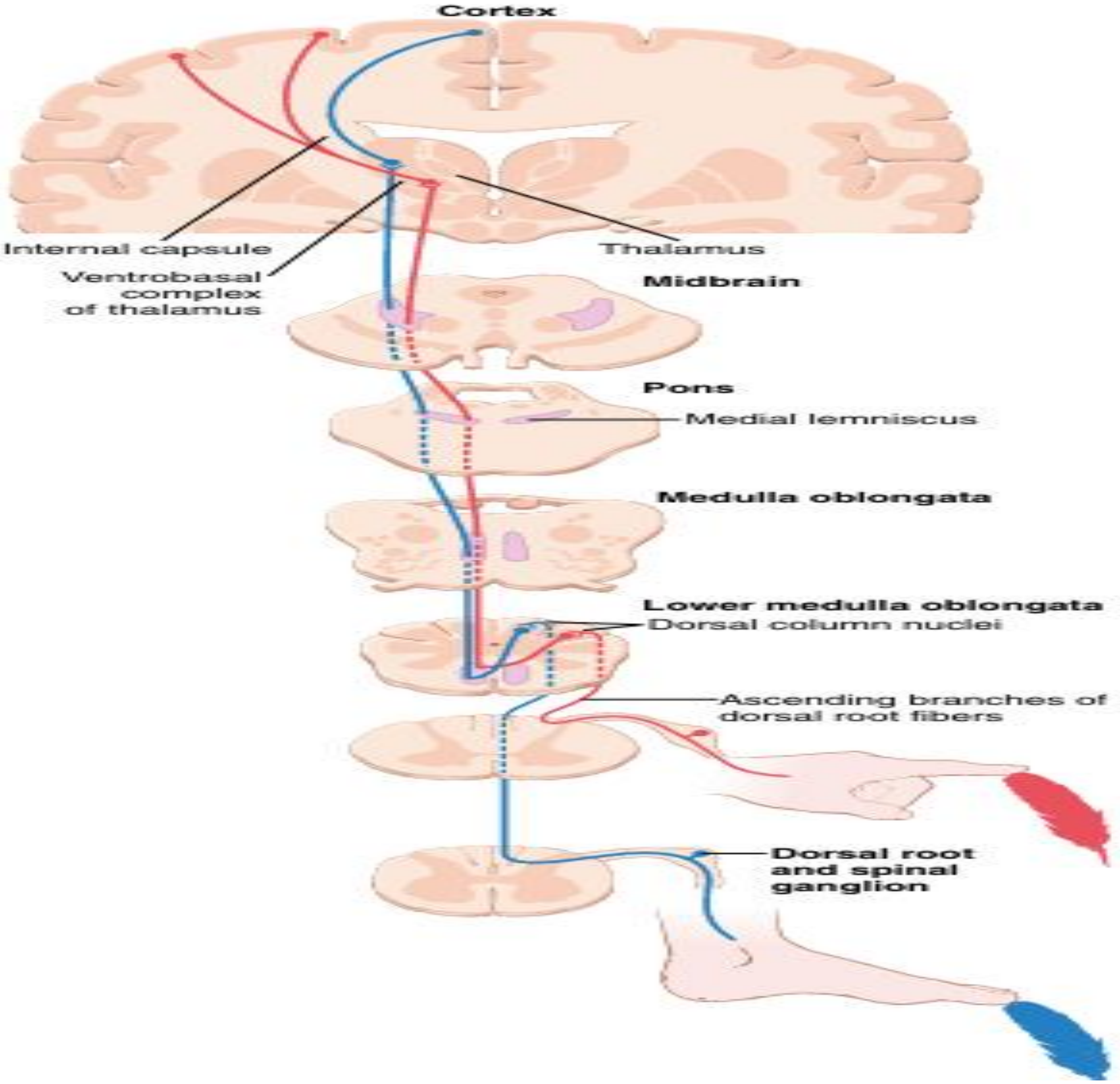
Dorsal Column–Medial Lemniscal System

1. Touch sensations requiring a high degree of localization of the stimulus
2. Touch sensations requiring transmission of fine gradations of intensity
3. Phasic sensations, such as vibratory sensations
4. Sensations that signal movement against the skin
5. Position sensations from the joints
6. Pressure sensations related to fine degrees of judgment of pressure intensity

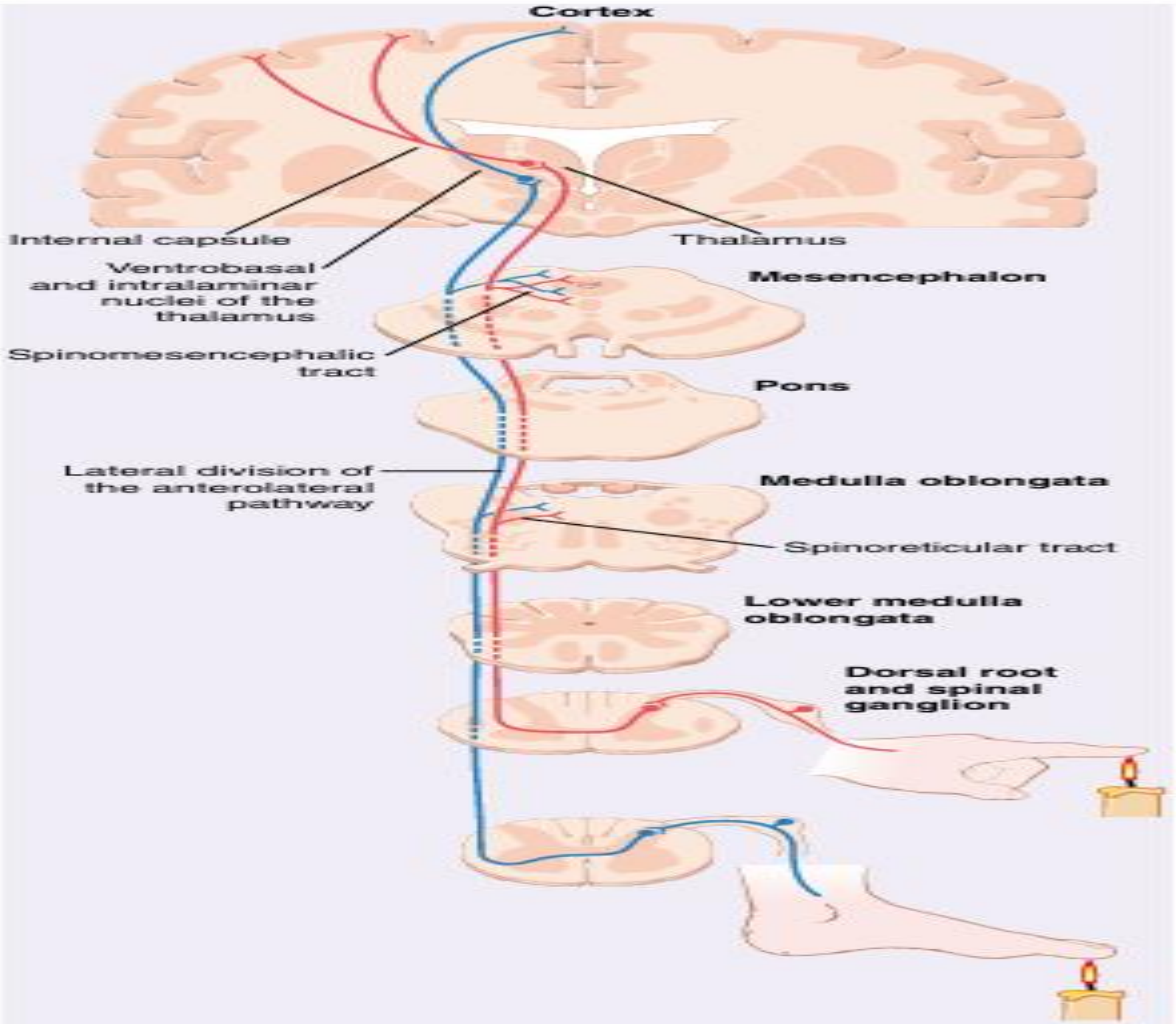
Anterolateral System

1. Pain
2. Thermal sensations, including both warm and cold sensations
3. Crude touch and pressure sensations capable only of crude localizing ability on the surface of the body
4. Tickle and itch sensations
5. Sexual sensations

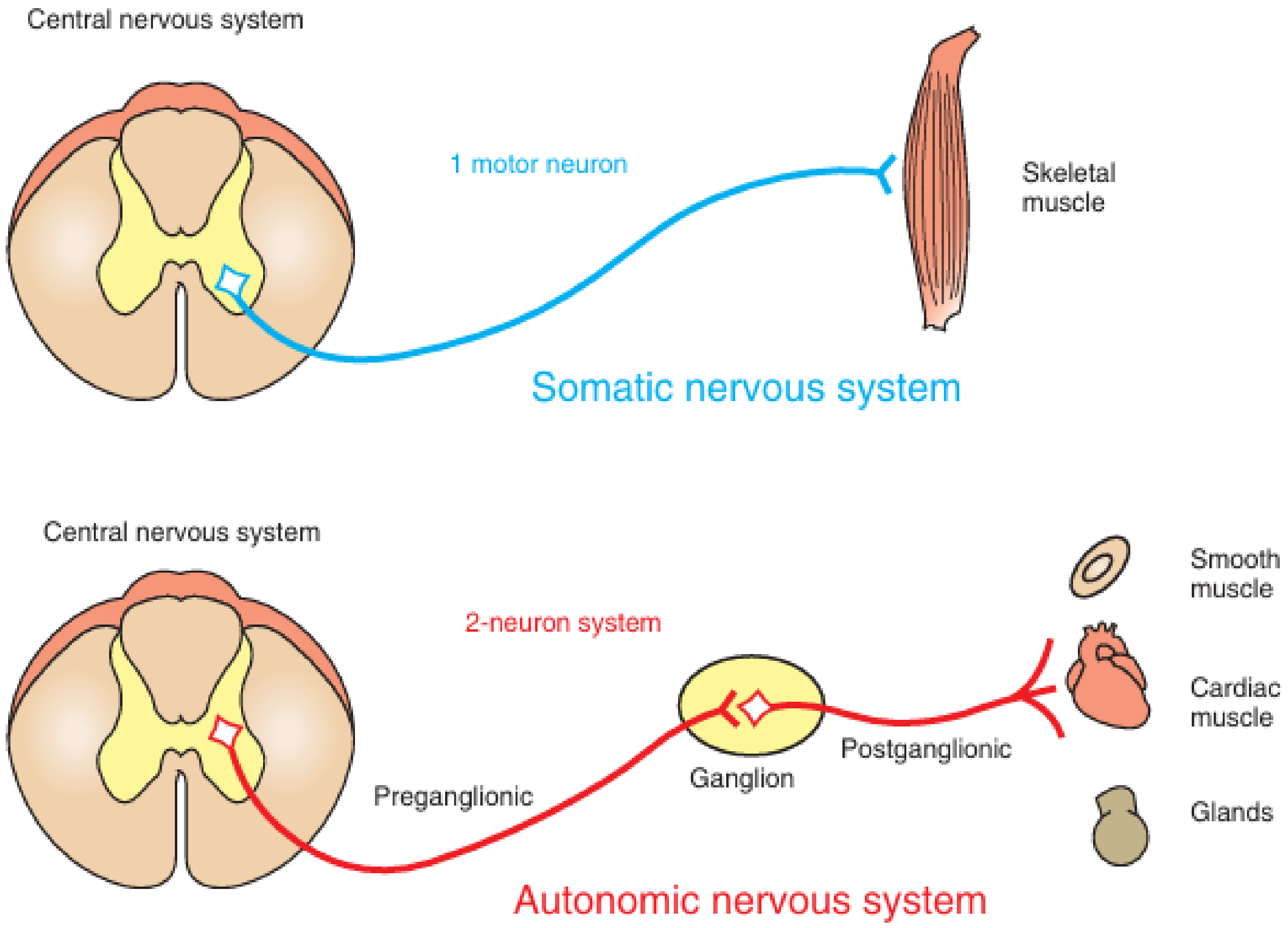
Neurophysiology



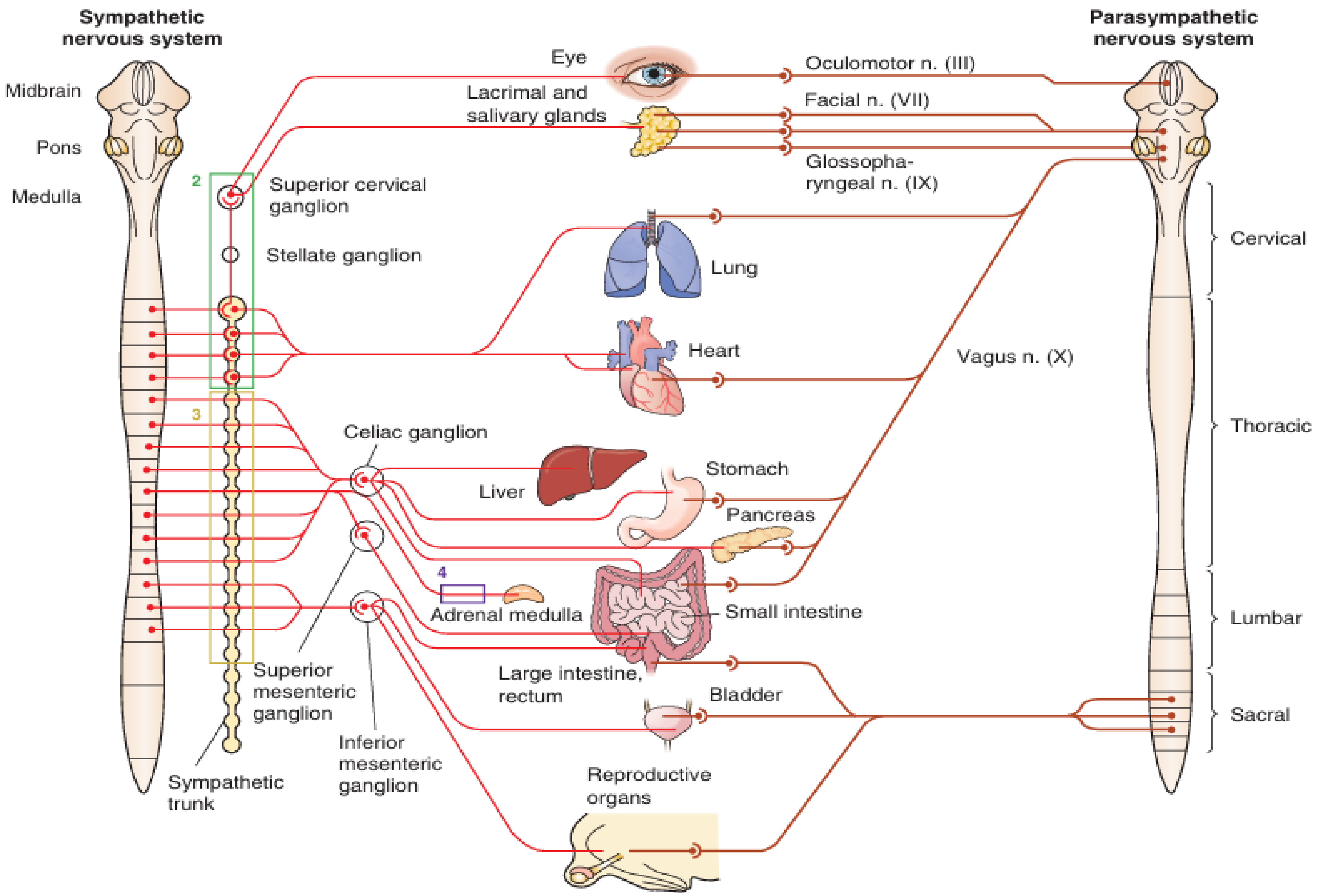
Neurophysiology



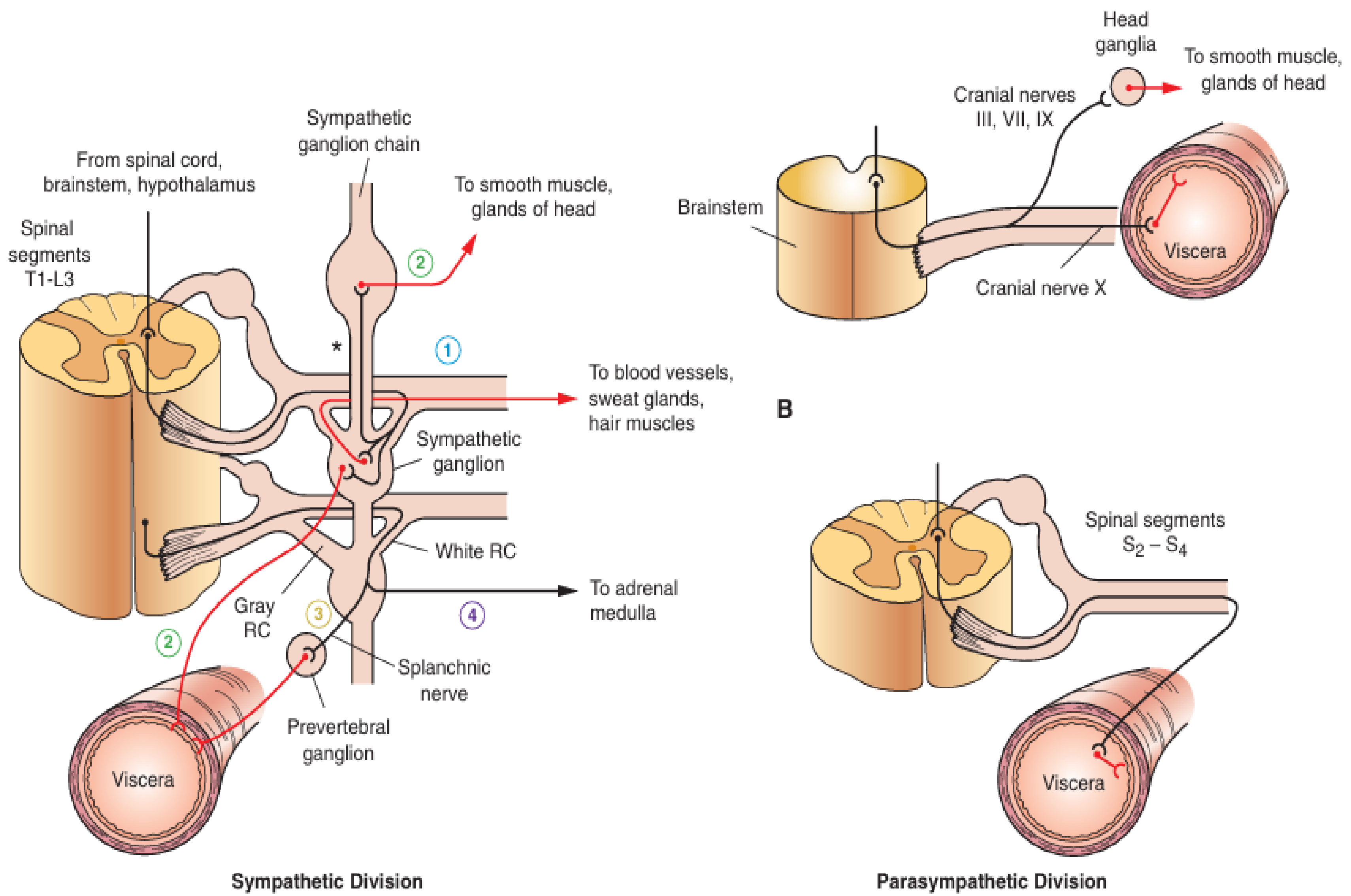
Neurophysiology



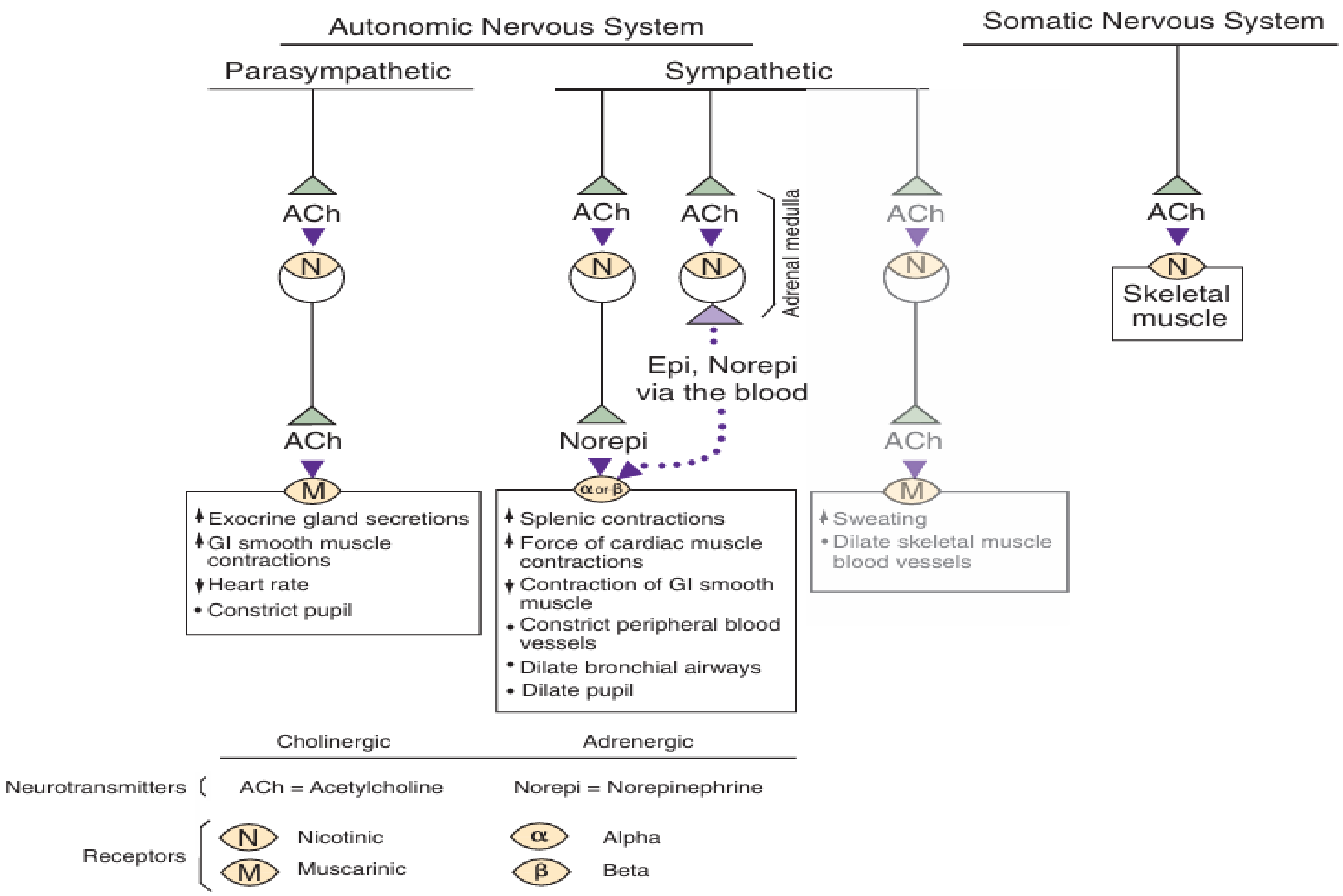
Neurophysiology



Neurophysiology



Neurophysiology

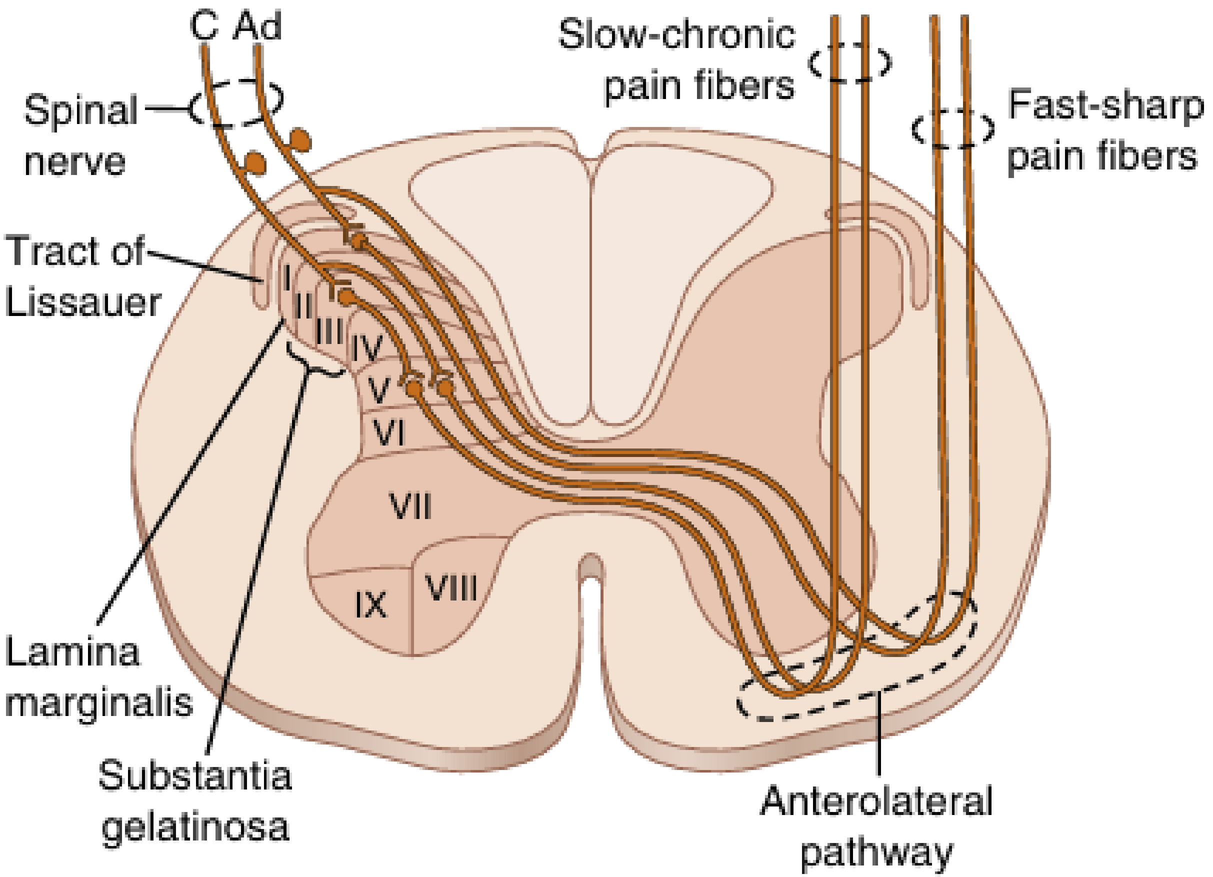


Neurophysiology

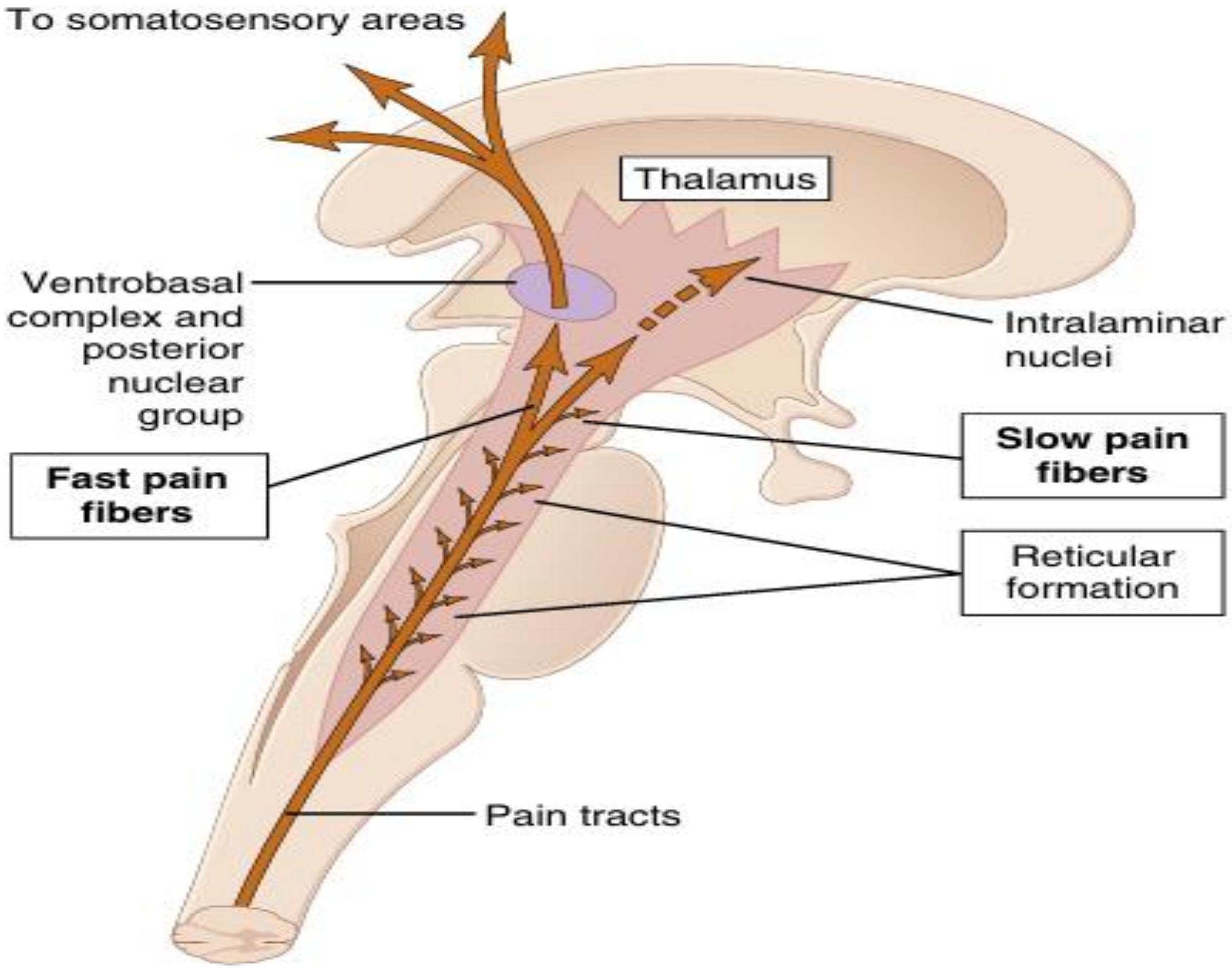
Table 10.1 Innervation of tissues and organs by the autonomic nervous system.

Target organ and tissue	Sympathetic division	Receptor type	Parasympathetic division
Skin			
Apocrine sweat glands	Increase in secretion	β_2	—
Merocrine sweat glands	Increase in secretion	M_3	—
Arrector pili	Erection	α_1	—
Eye			
Iris: dilator muscle	Pupillary dilation	α_1	—
Sphincter muscle	—	—	Pupillary constriction
Ciliary muscle	—	—	Contraction (near vision)
Lung			
Bronchiolar muscle	Relaxation	β_2	Contraction
Heart			
SA node	Increase in heart rate	β_1	Decrease in heart rate
AV node and Purkinje fibers	Increase in conduction velocity	β_1	Decrease in conduction velocity
Atria, ventricle	Increase in contractility	β_1	Decrease in contractility
Arterioles			
Skin and mucosa	Constriction	α	—
Salivary glands	Constriction	α	—
Cerebral	Slight constriction	α	—
Skeletal muscle	Dilation	β_2	—
Coronary	Dilation	β_2	Slight dilation
Pulmonary	Dilation	β_2	—
Abdominal viscera	Constriction	α	—
Veins (systemic)	Constriction, Dilation	α, β_2	—
Gastrointestinal system			
Stomach, intestinal tract	Decrease in motility*	α_2, β_2	Increase in motility
Sphincters	Contraction	α_1	Relaxation
Gastric gland	Decrease in secretion	α_2	Increase in secretion
Gallbladder	Relaxation	β_2	Contraction
Liver	Glycogenolysis, gluconeogenesis	α_1, β_2	Glycogen synthesis
Pancreas			
Acini	Decrease in secretion	α	Increased secretion
Islets	Decrease in secretion	α_2	—
Adrenal medulla	Secretion of E and NE	N	—
Kidney	Renin secretion	β_2	—
Urinary bladder			
Detrusor muscle	Relaxation	β_3	Contraction
Trigone and sphincter	Contraction	α_1	Relaxation
Reproductive organs			
Penis	Ejaculation	α_1	Erection
Uterus (pregnant)	Contraction	α_1	Variable
Uterus (nonpregnant)	Relaxation	β_2	Variable
Glands			
Lacrimal	Slight secretion	α	Increase in secretion
Salivary	Slight viscous secretion	α	Increase in watery secretion
Nasopharyngeal	—	—	Secretion
Pineal	Melatonin synthesis	β	—

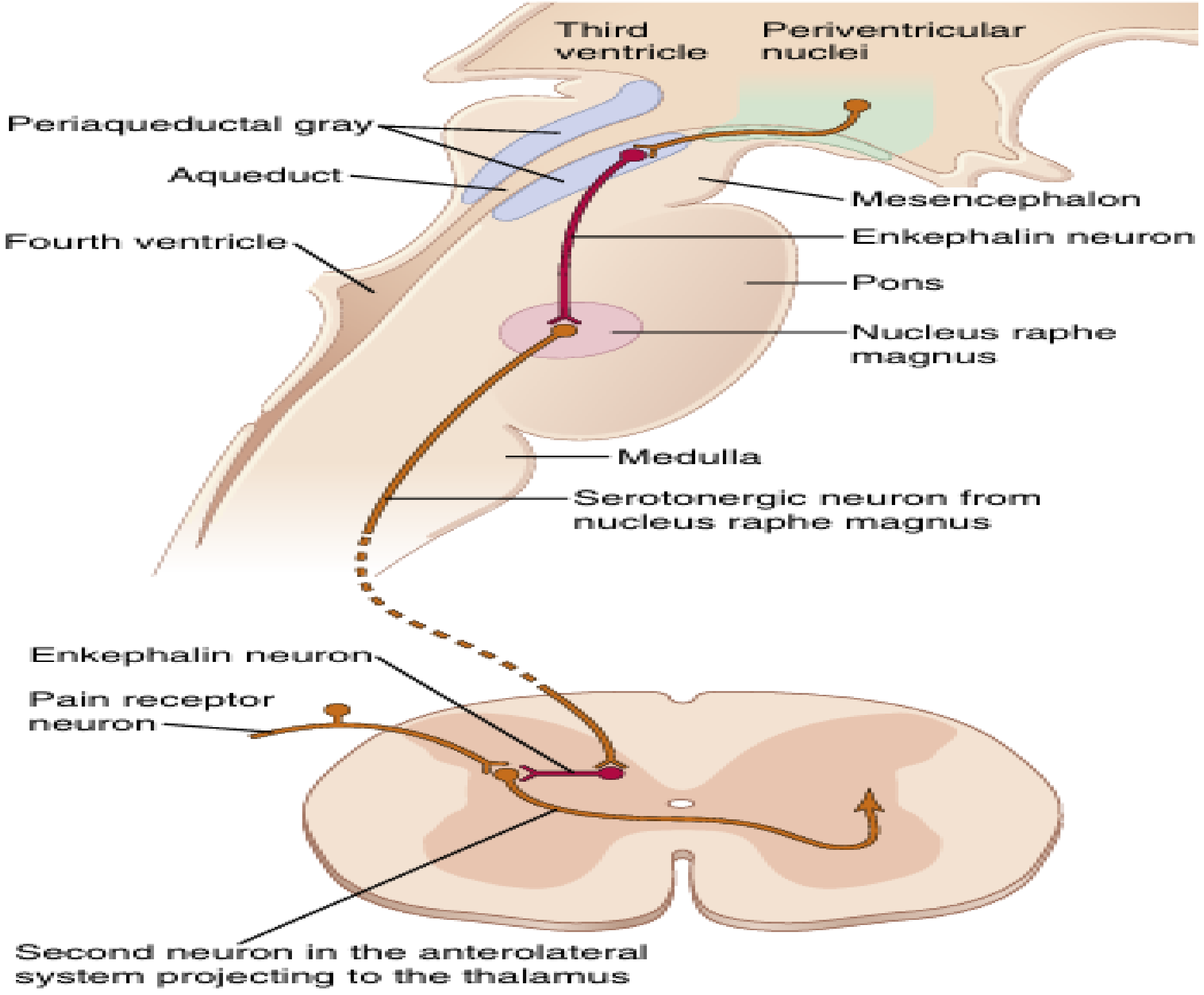
Neurophysiology



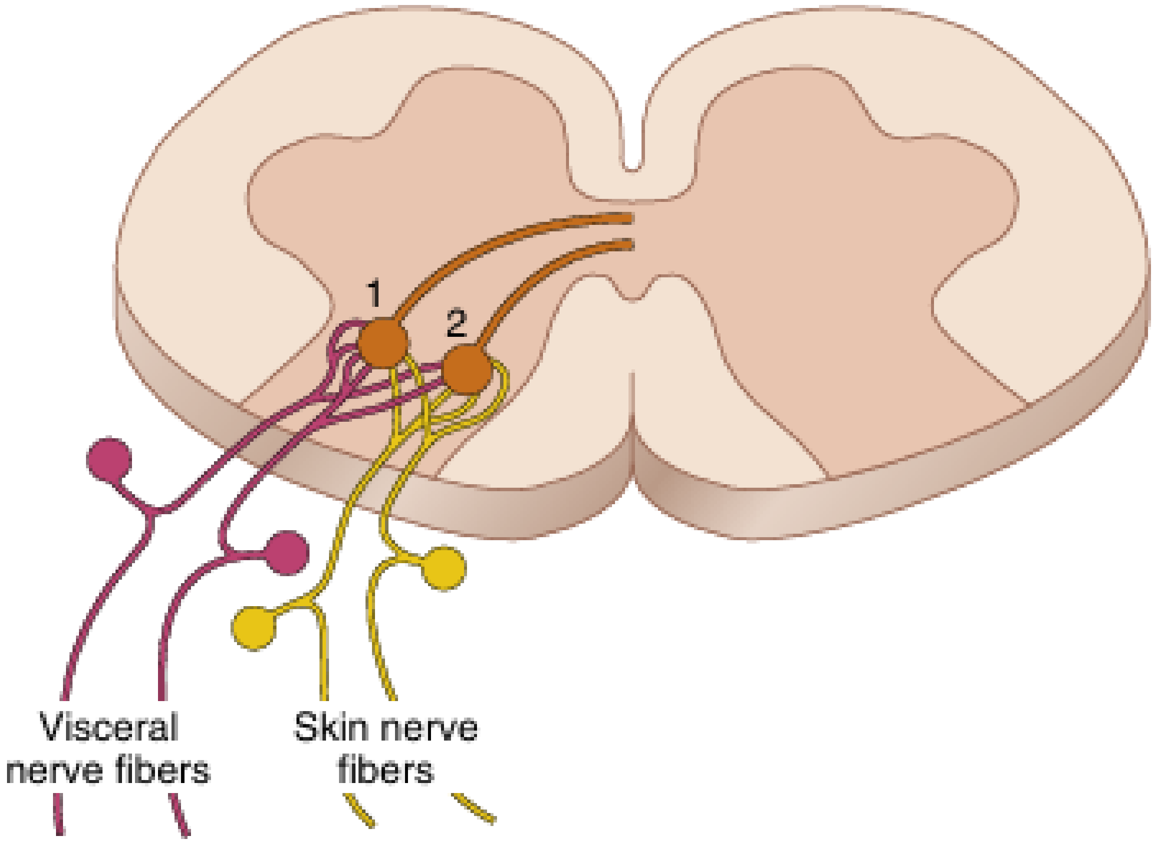
Neurophysiology



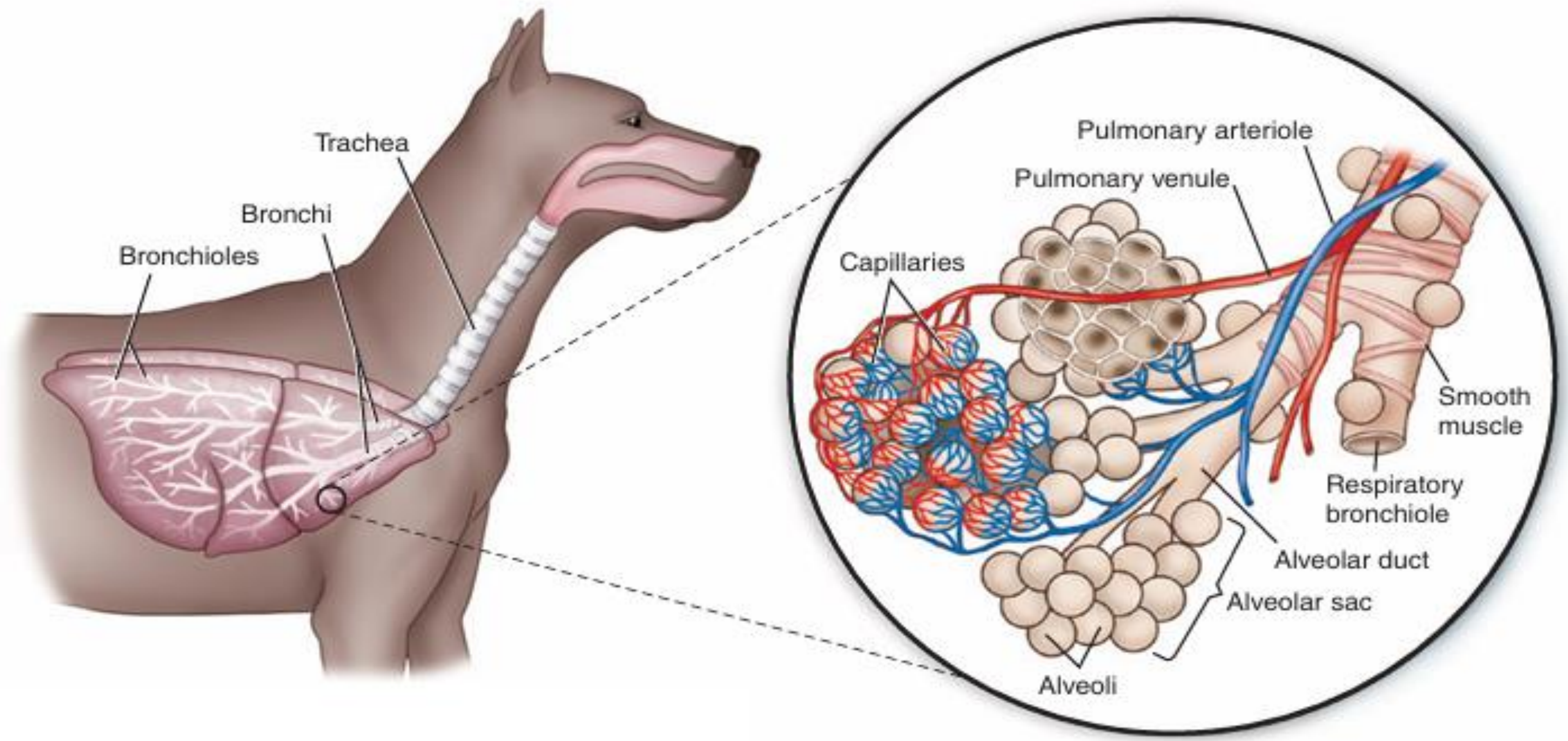
Neurophysiology



Neurophysiology

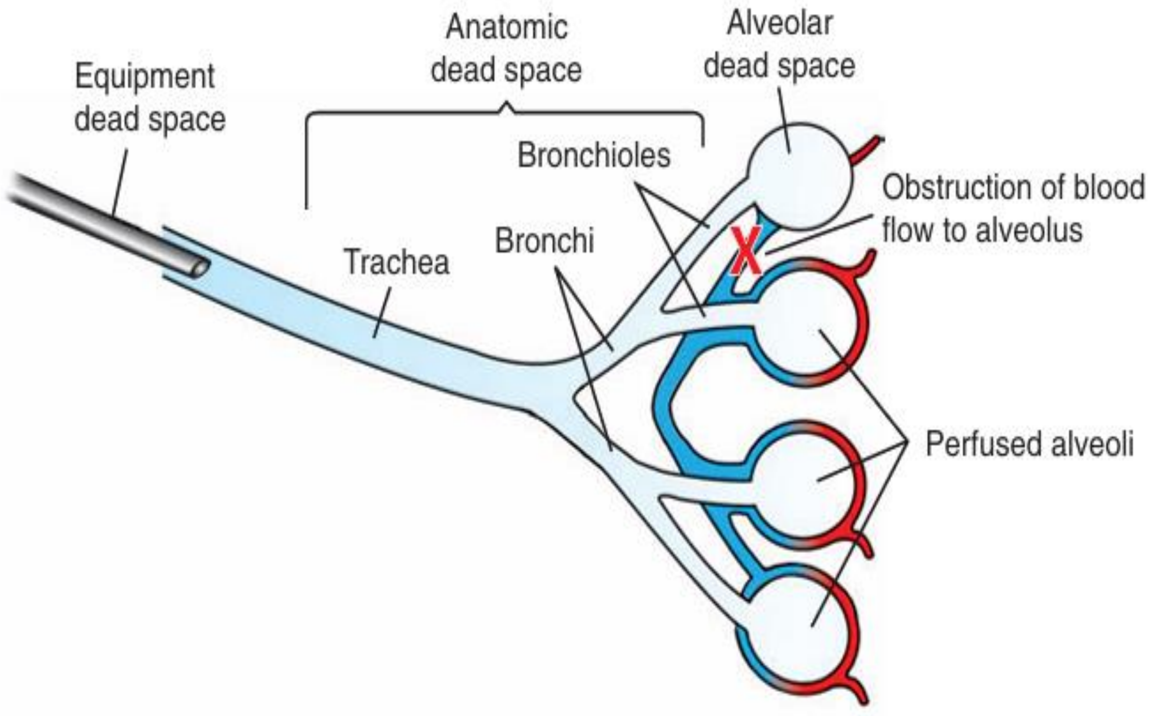


Physiology of Respiratory System

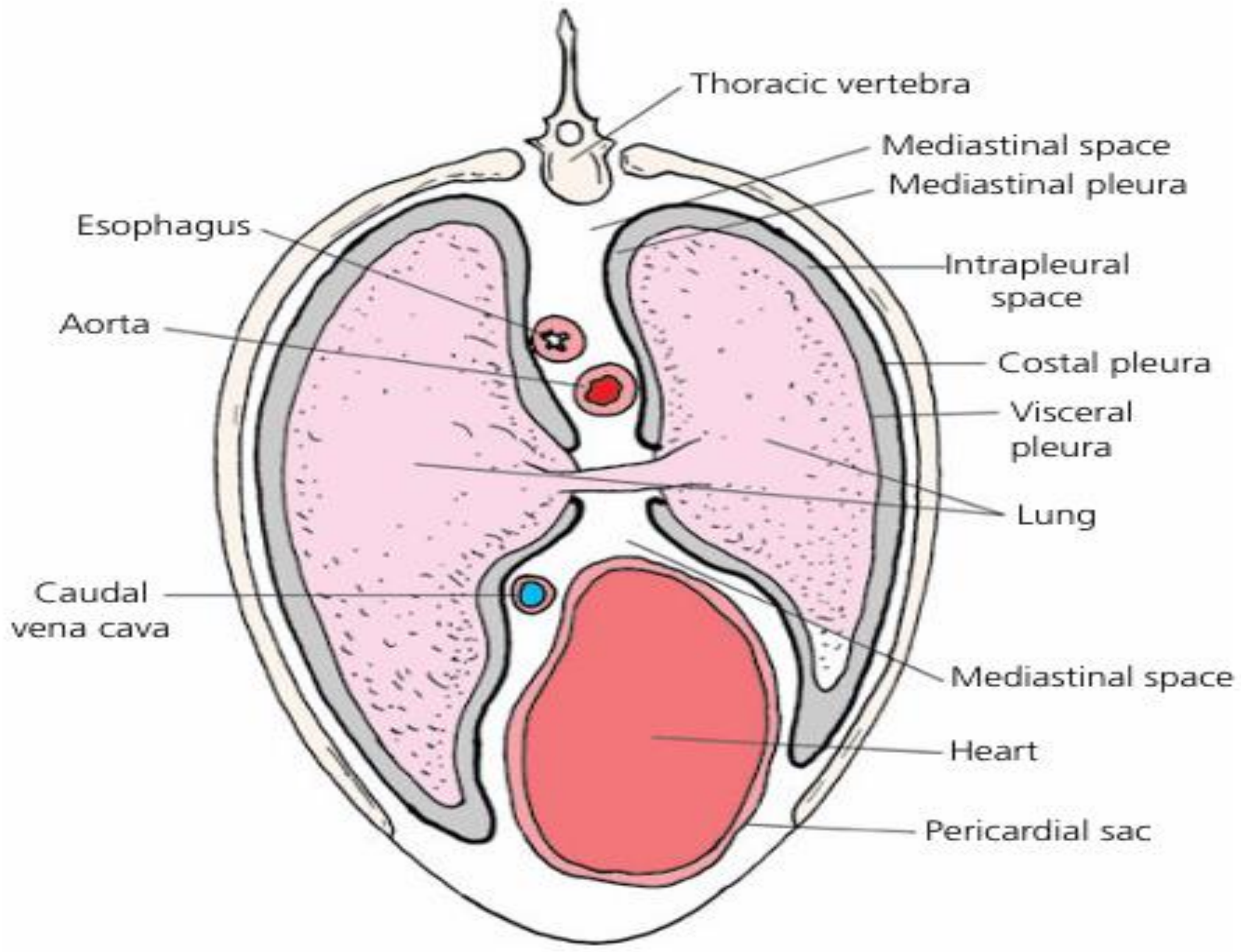


Physiology of Respiratory System

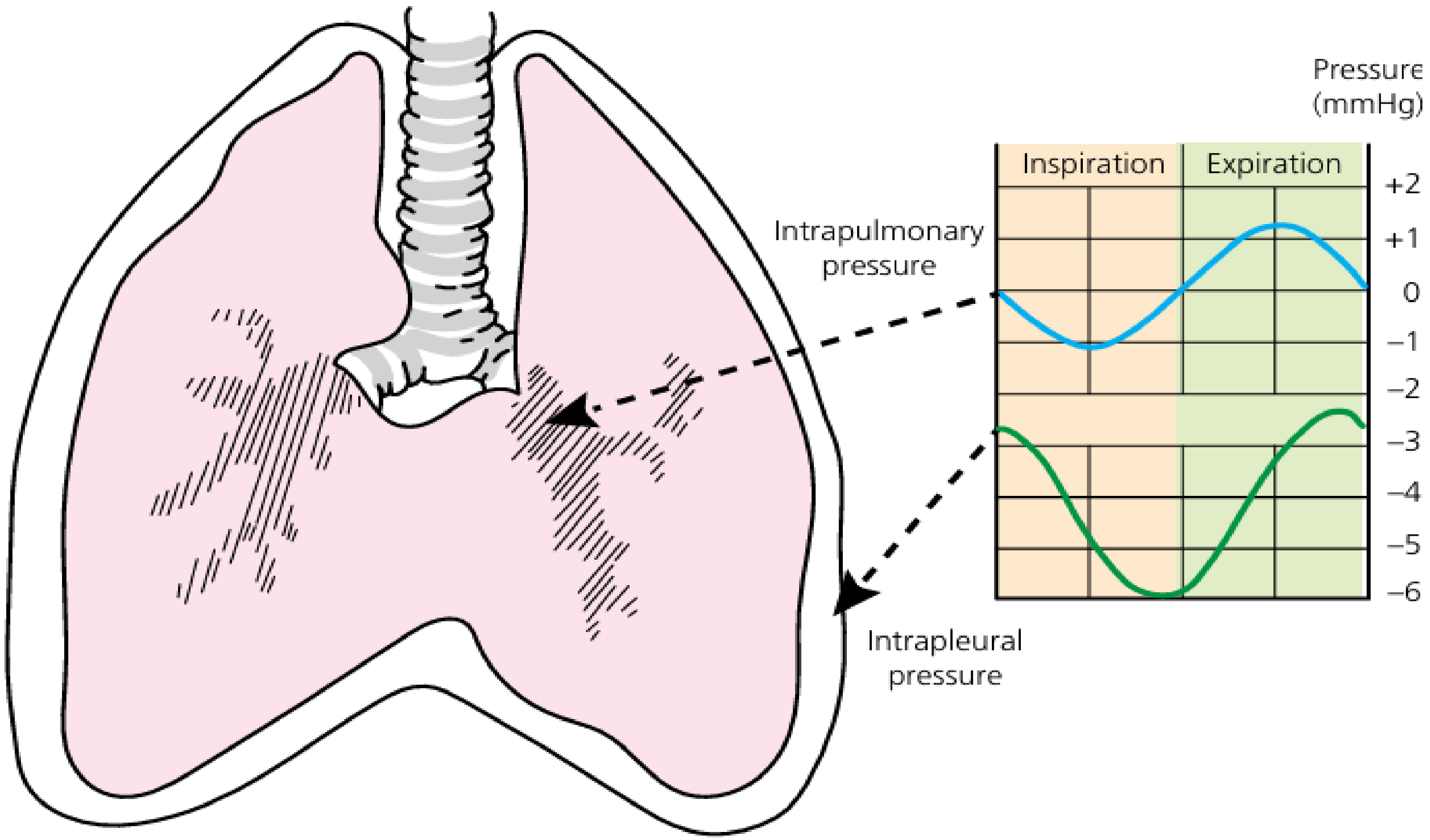
Alveolar Ventilation is the Fresh Air Per Minute That Reaches Perfused Alveoli While Dead Space Ventilation Remains in the Conducting Airways



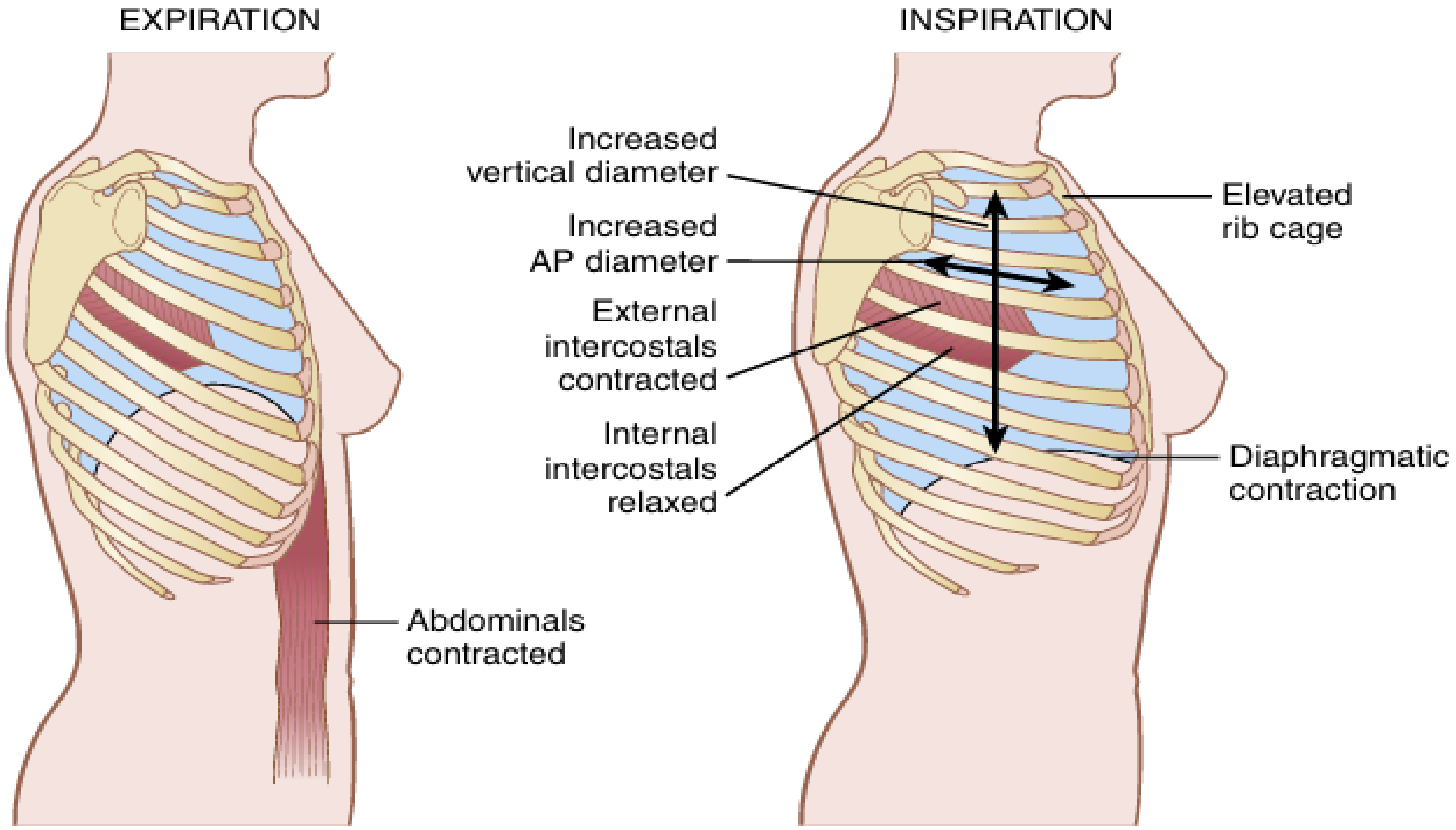
Physiology of Respiratory System



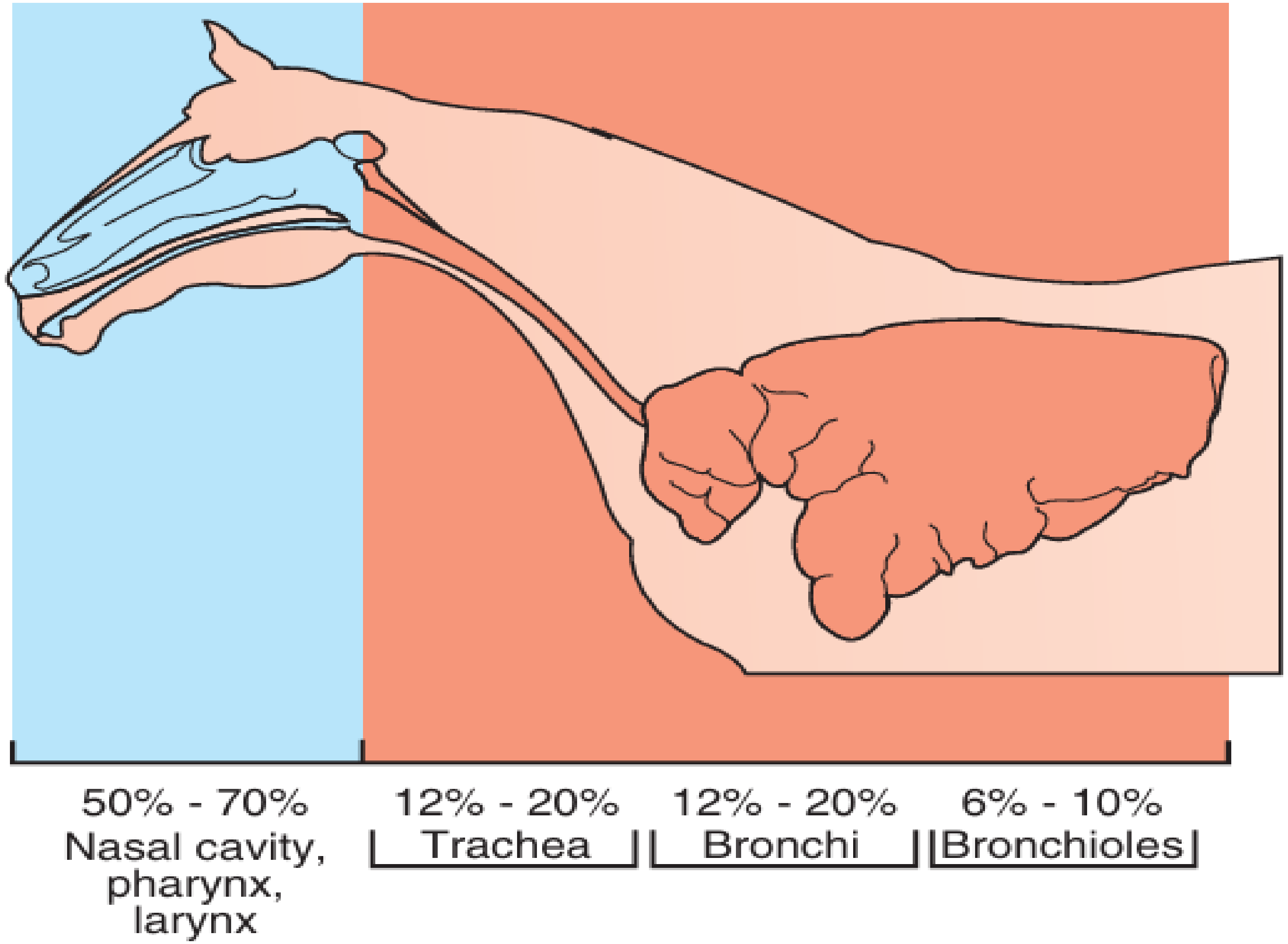
Physiology of Respiratory System



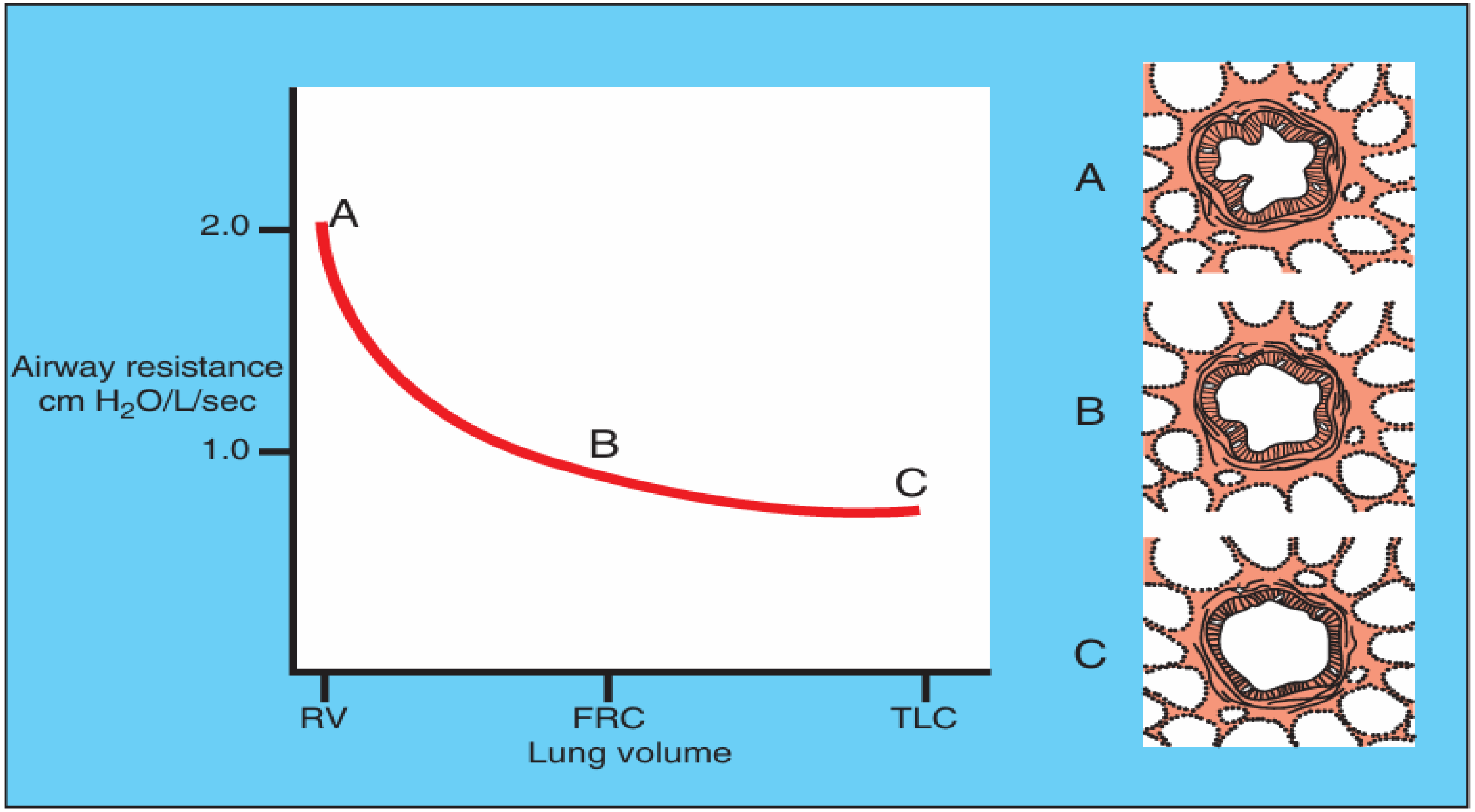
Physiology of Respiratory System



Physiology of Respiratory System

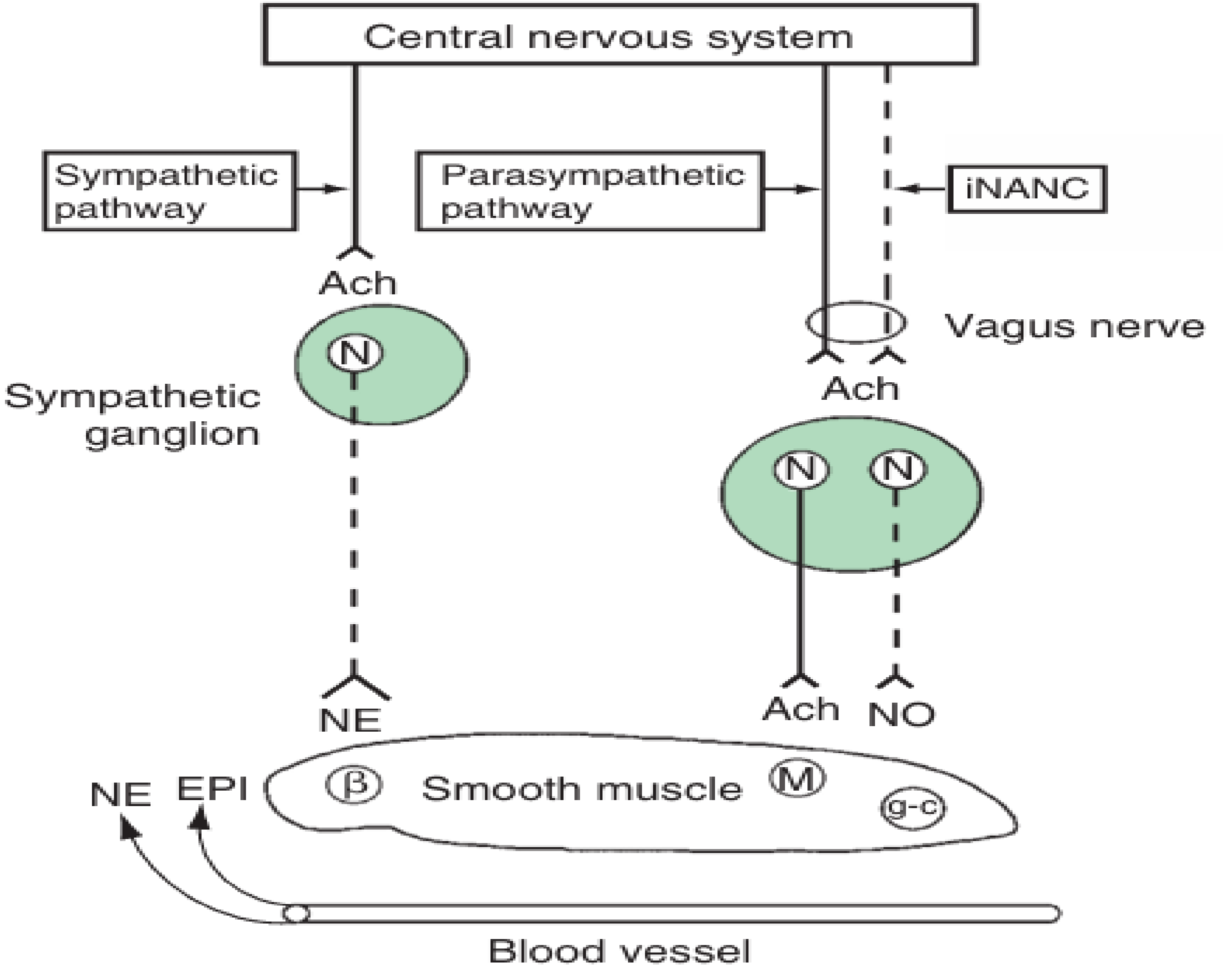


Physiology of Respiratory System



- **Fig. 45.11** Effect of change in lung volume on airway resistance. The airway is represented in the diagrams on the right side of the figure by the *large circle,* to which are attached alveoli, the septa of which link the airway wall to the pleural surface. As lung volume increases, the alveolar septa become stretched, apply tension to the airway walls, and thus dilate the airway and reduce resistance. *FRC,* Functional residual capacity; *RV,* residual volume; *TLC,* total lung capacity.

Physiology of Respiratory System



Physiology of Respiratory System

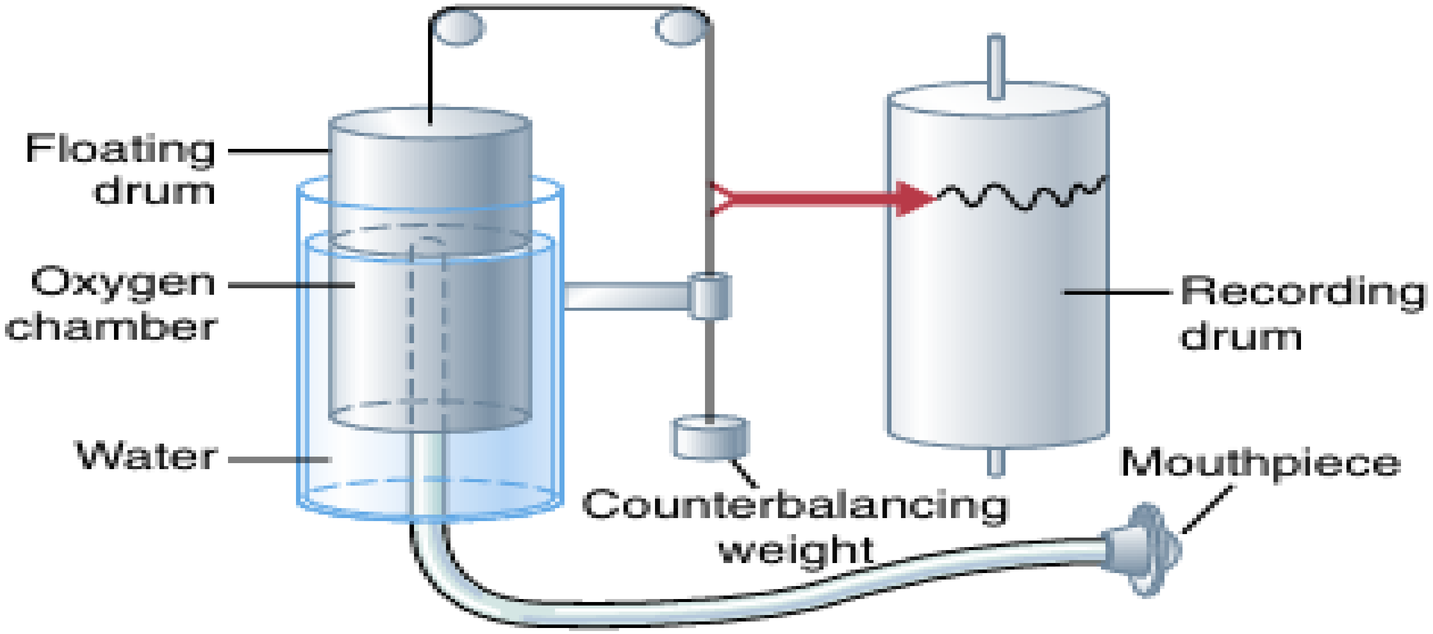
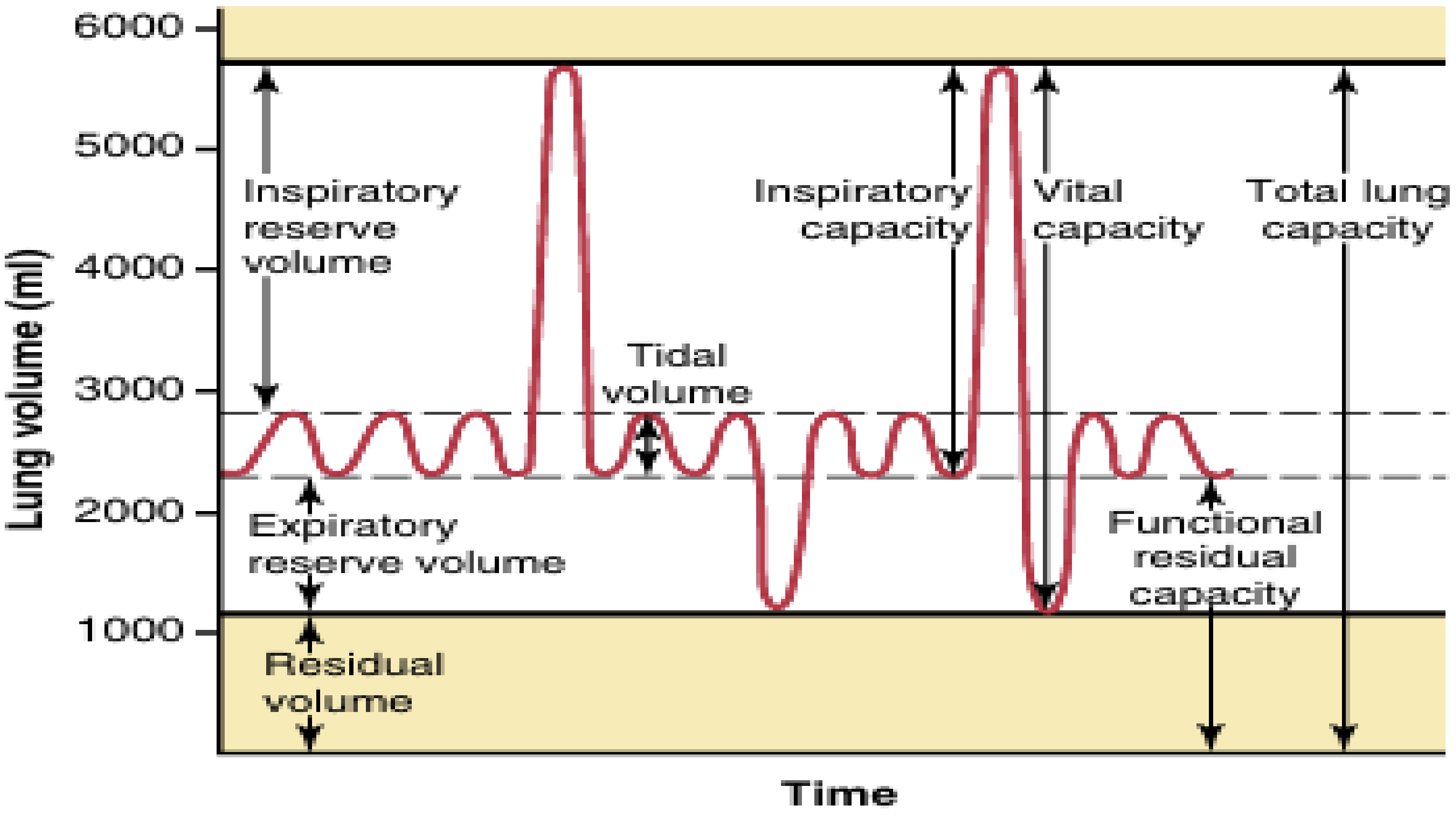
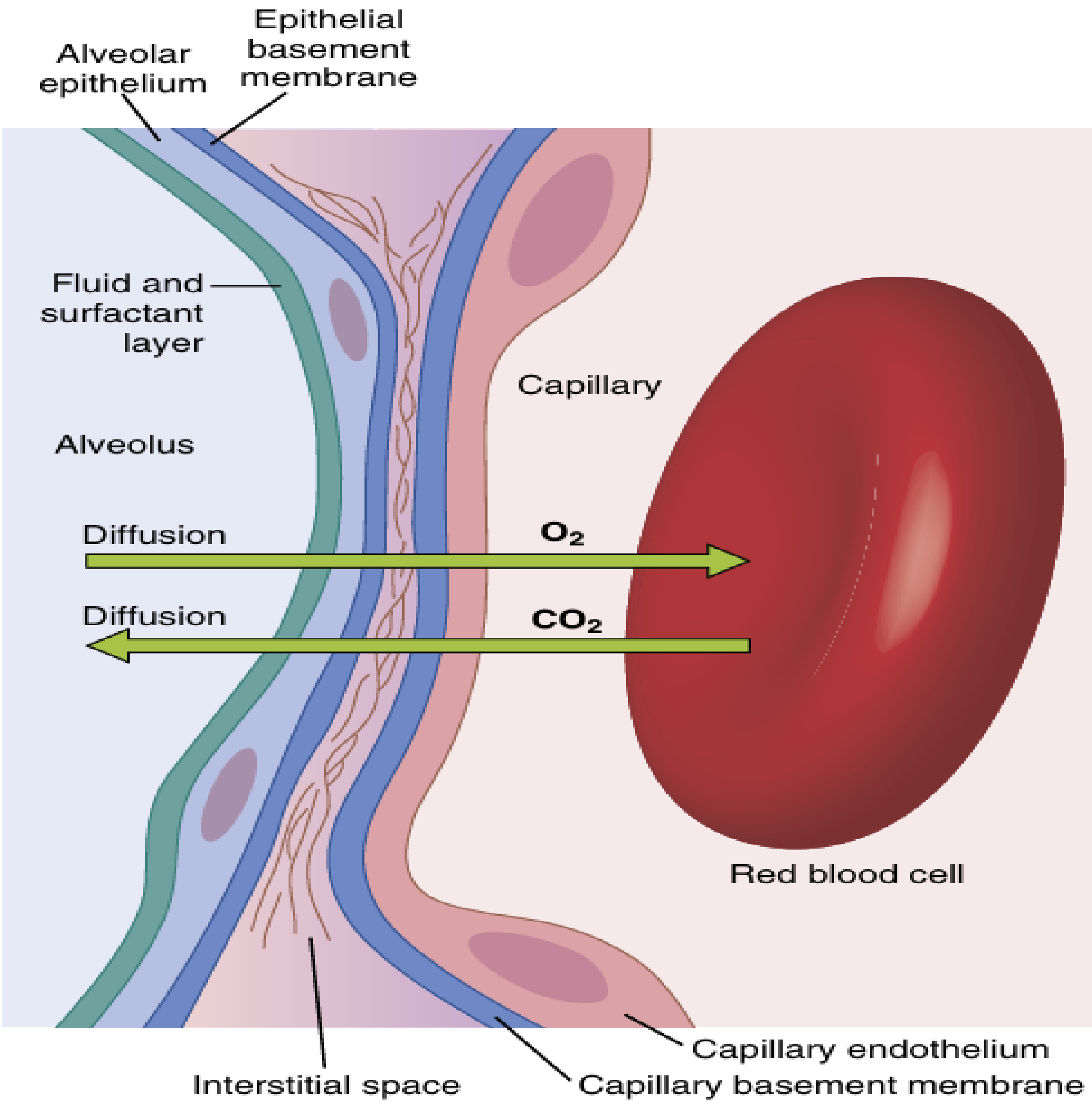


Figure 38-5 Spirometer.

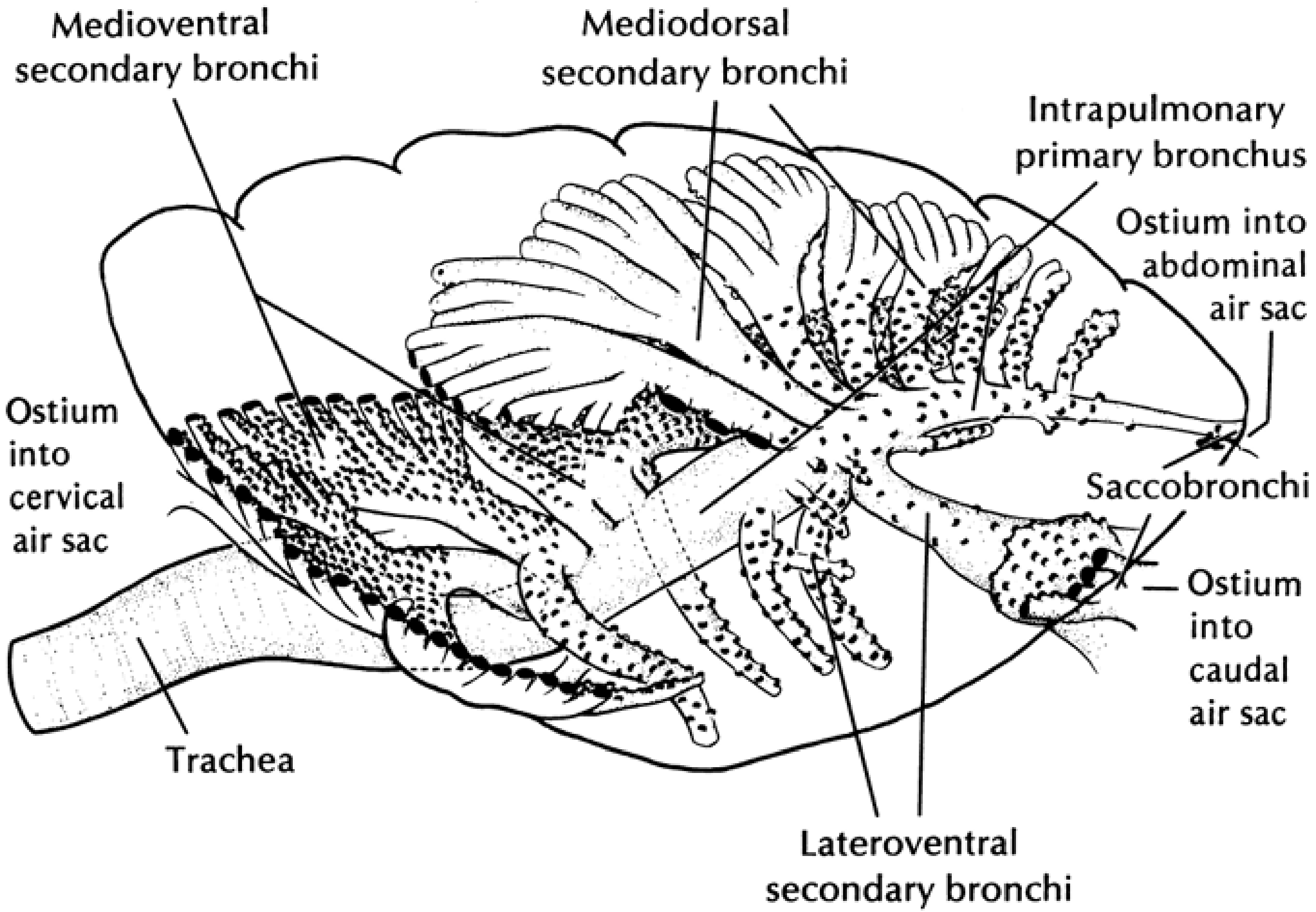
Physiology of Respiratory System



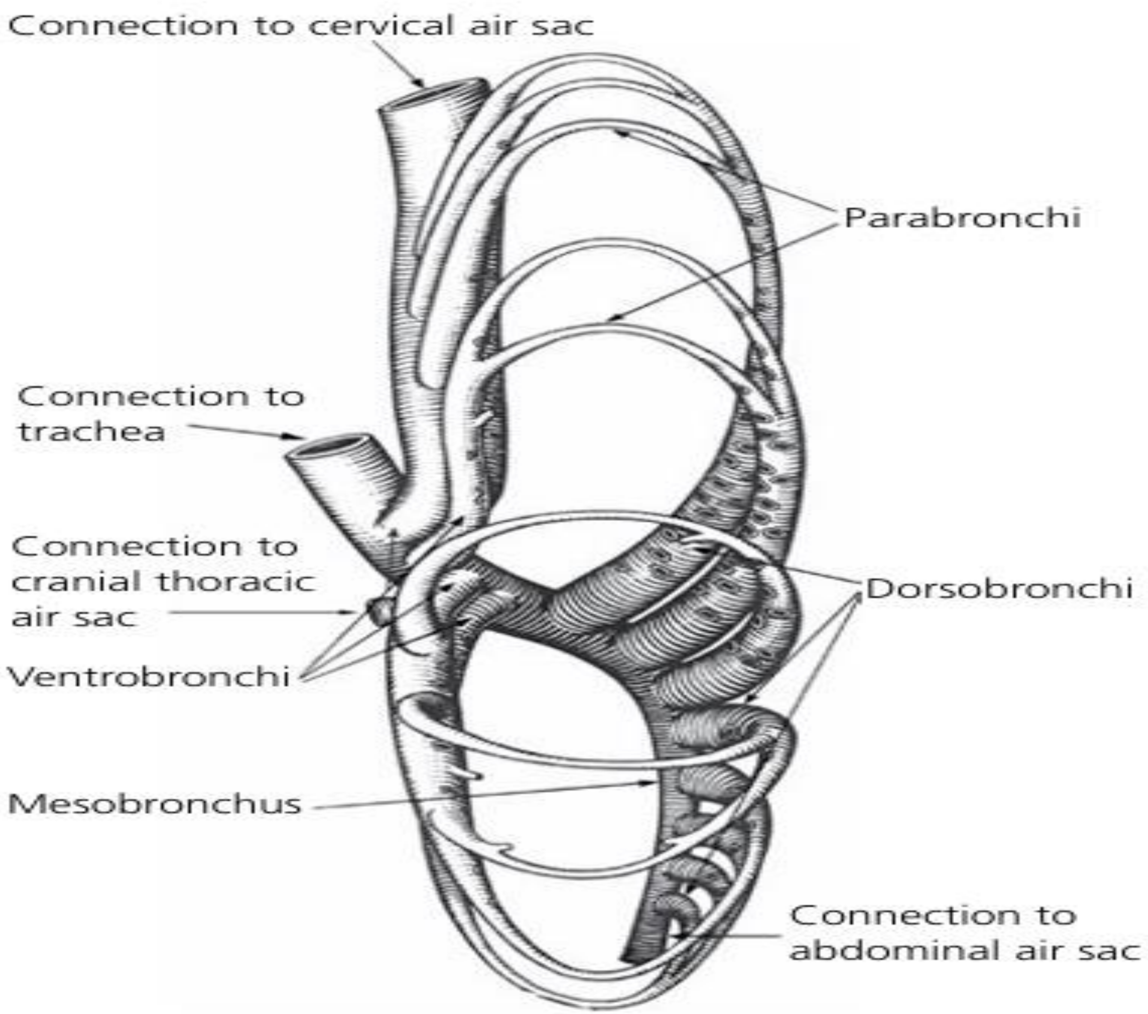
Physiology of Respiratory System



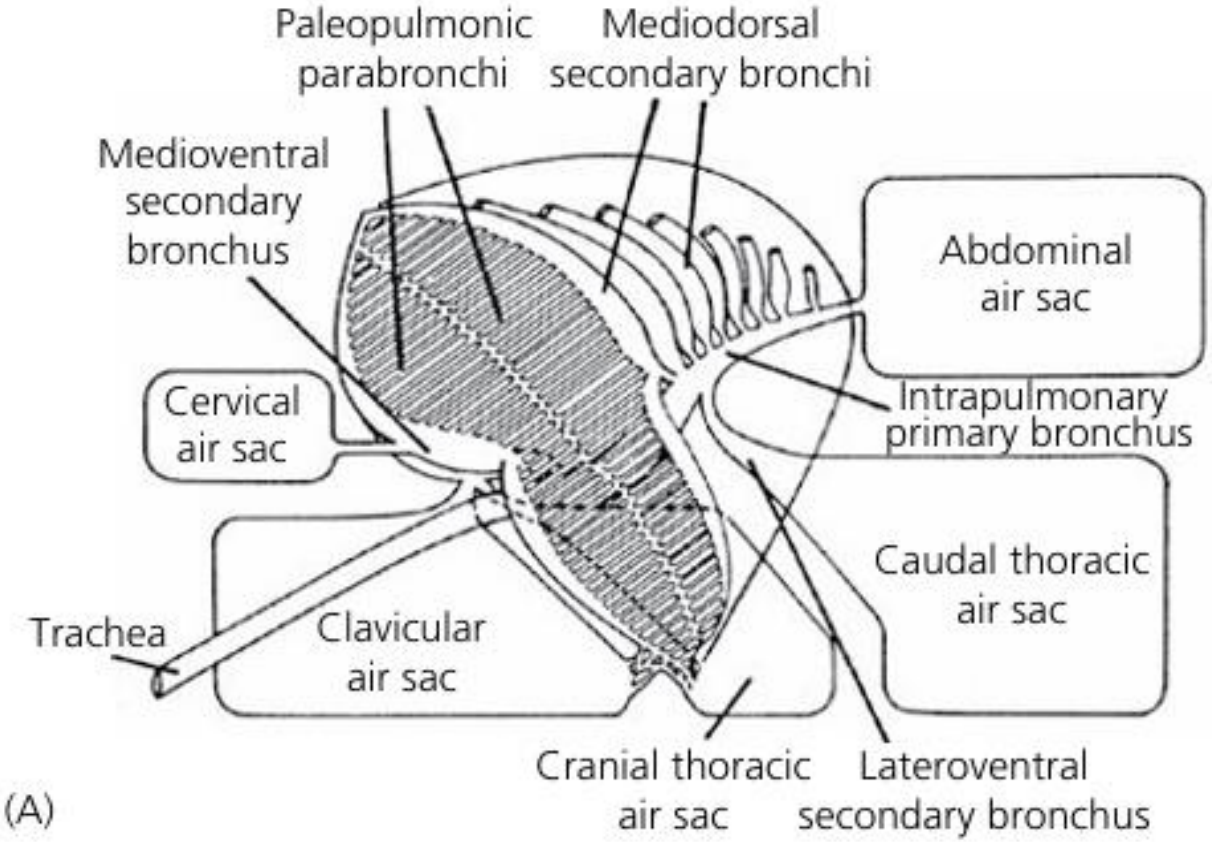
Physiology of Respiratory System



Physiology of Respiratory System

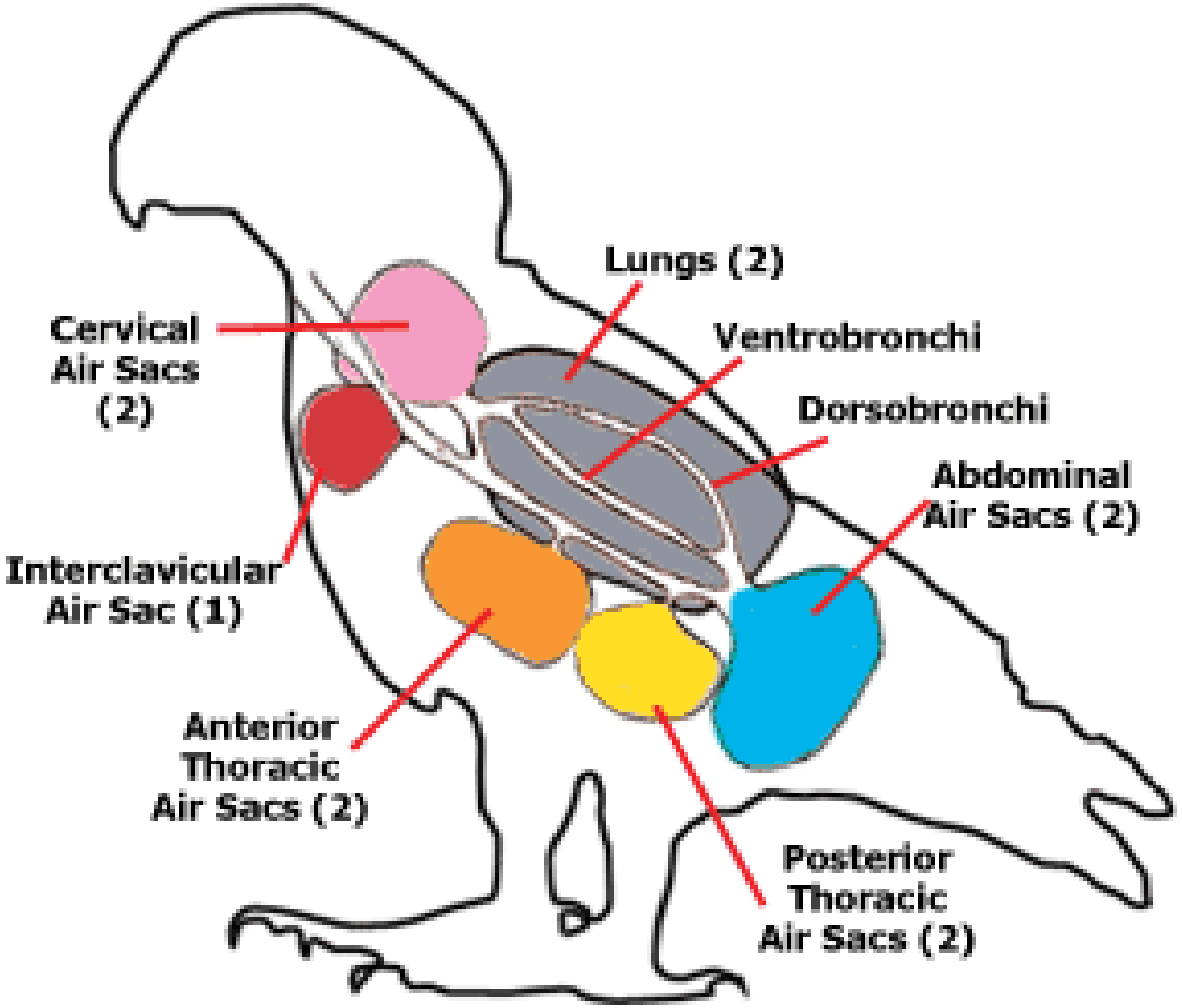


Physiology of Respiratory System

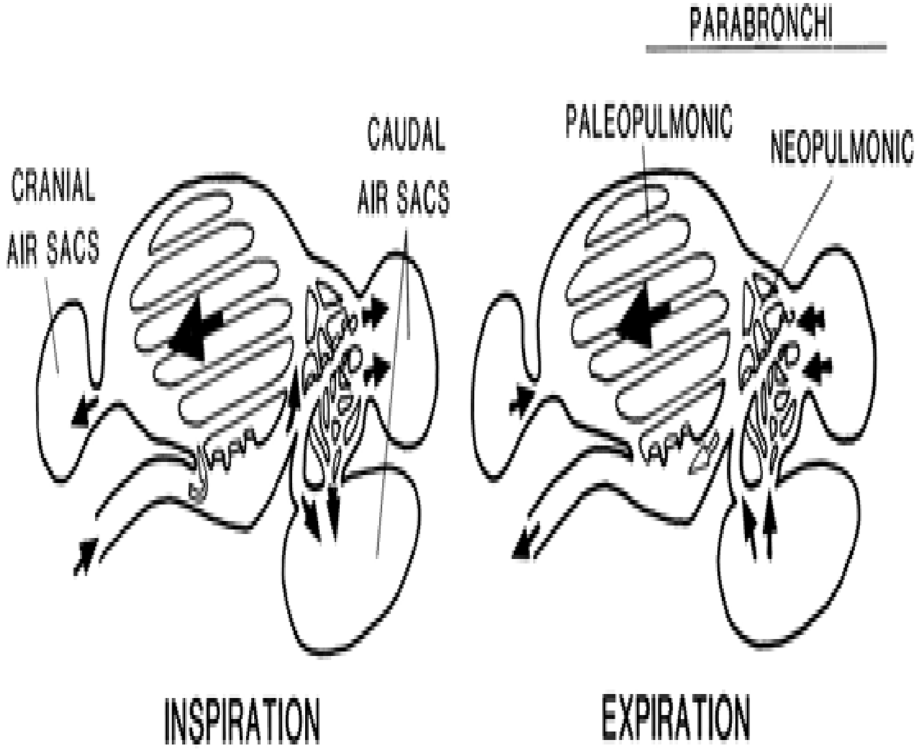


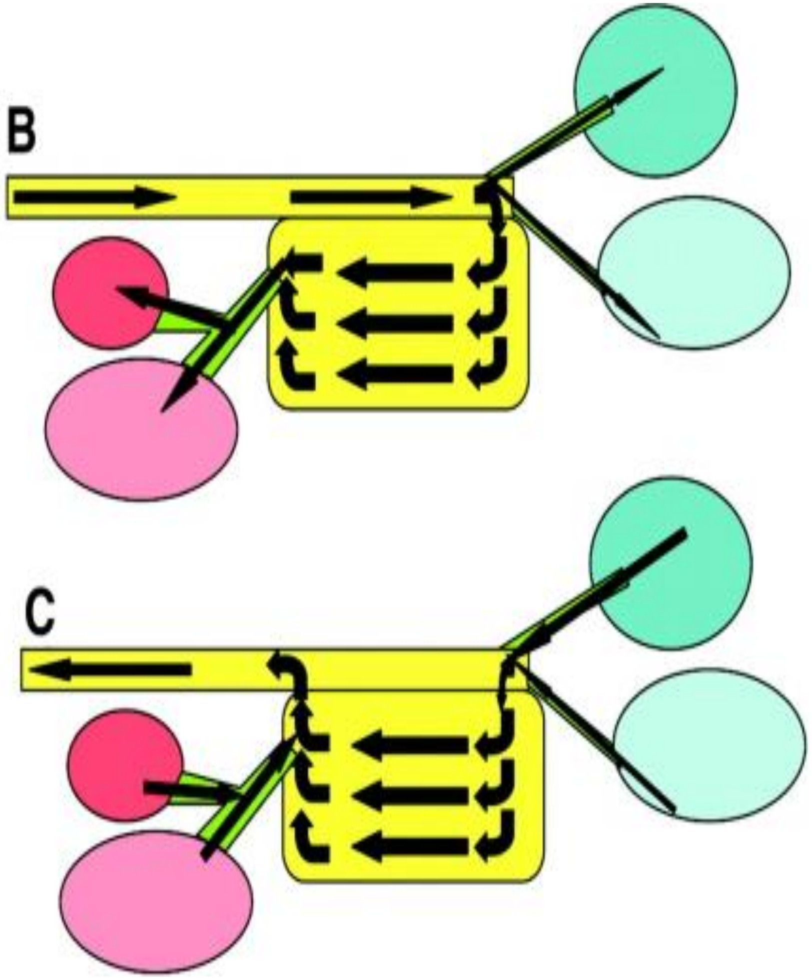
(A)

Physiology of Respiratory System



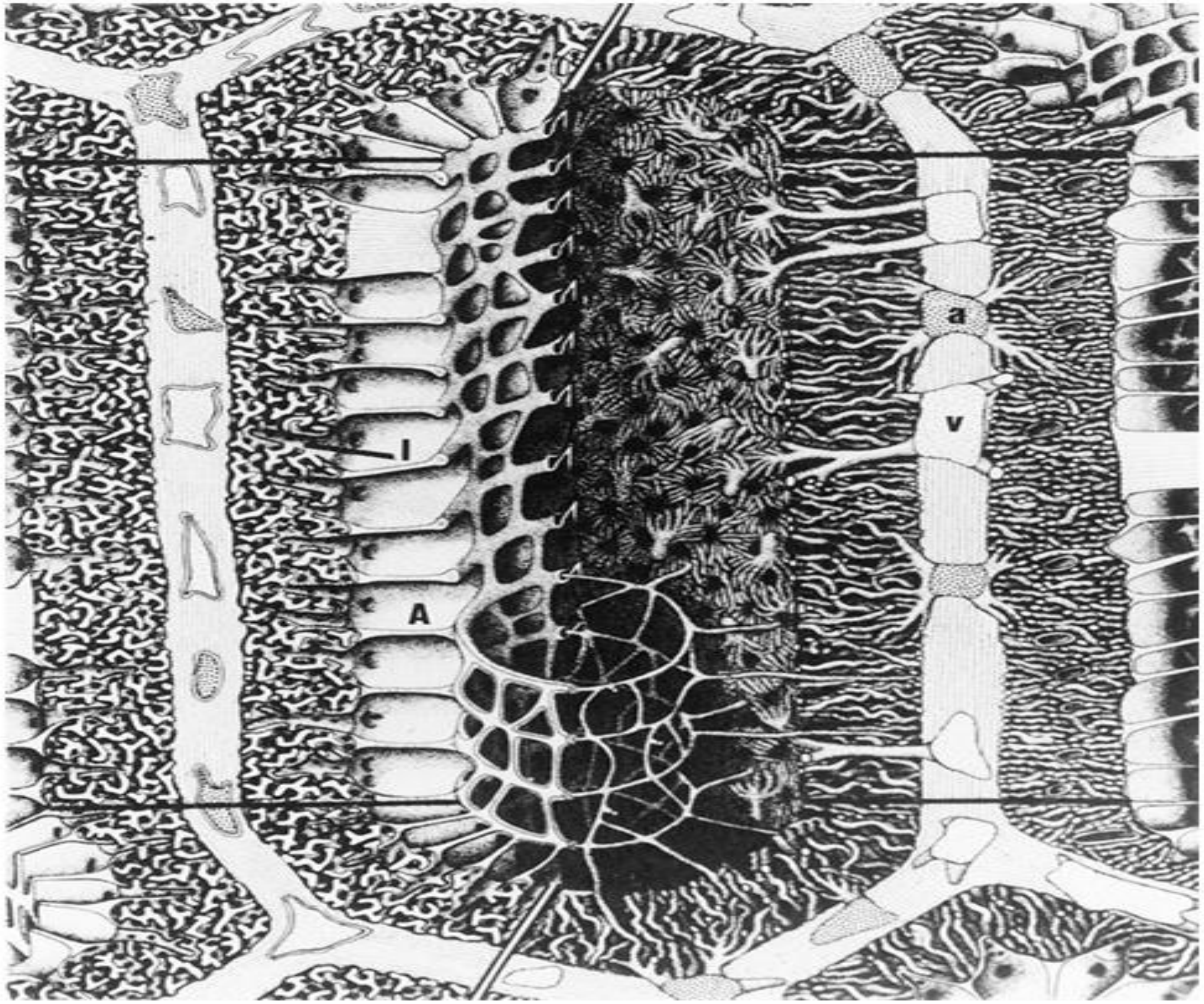
Physiology of Respiratory System



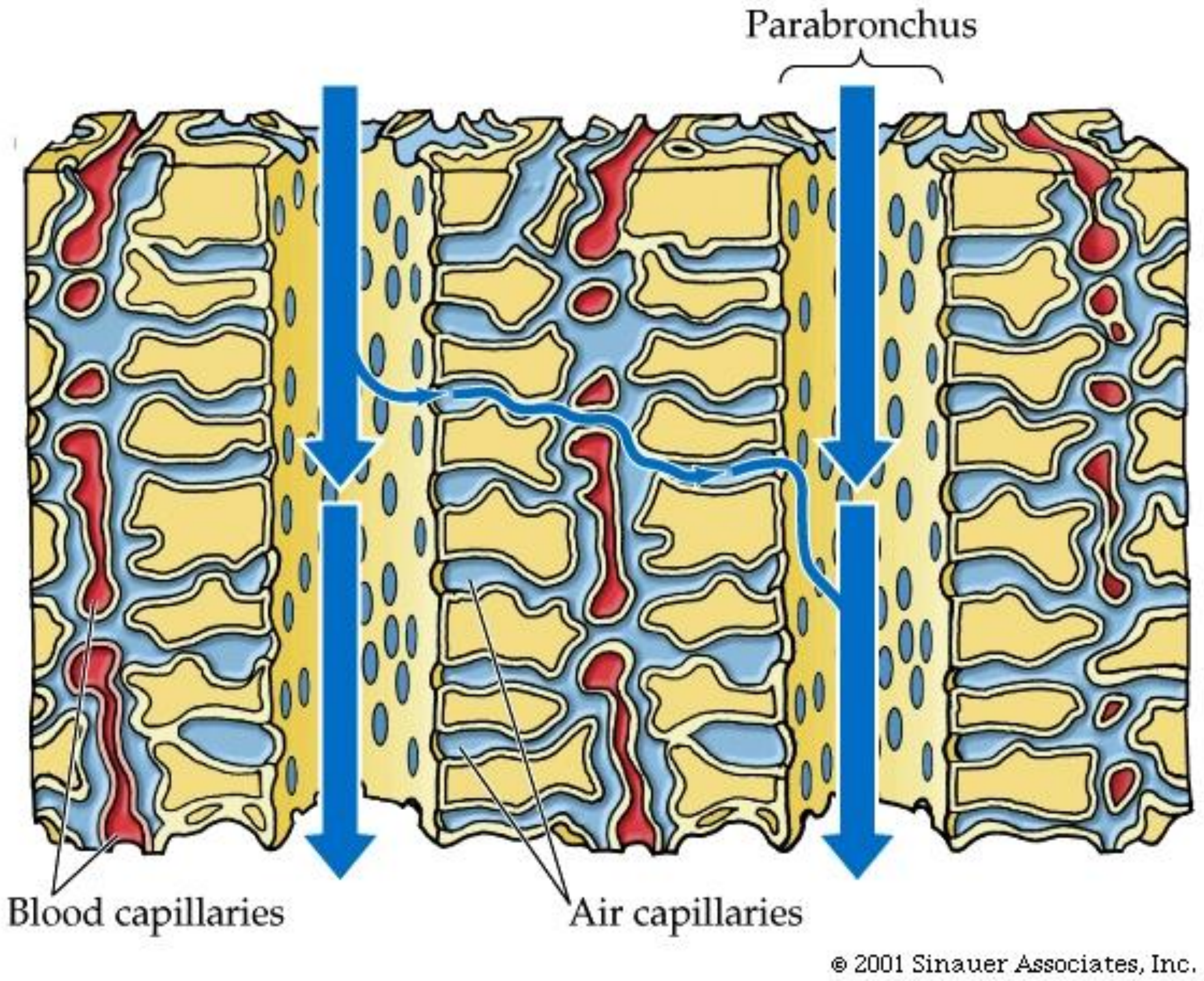


Physiology of Respiratory System

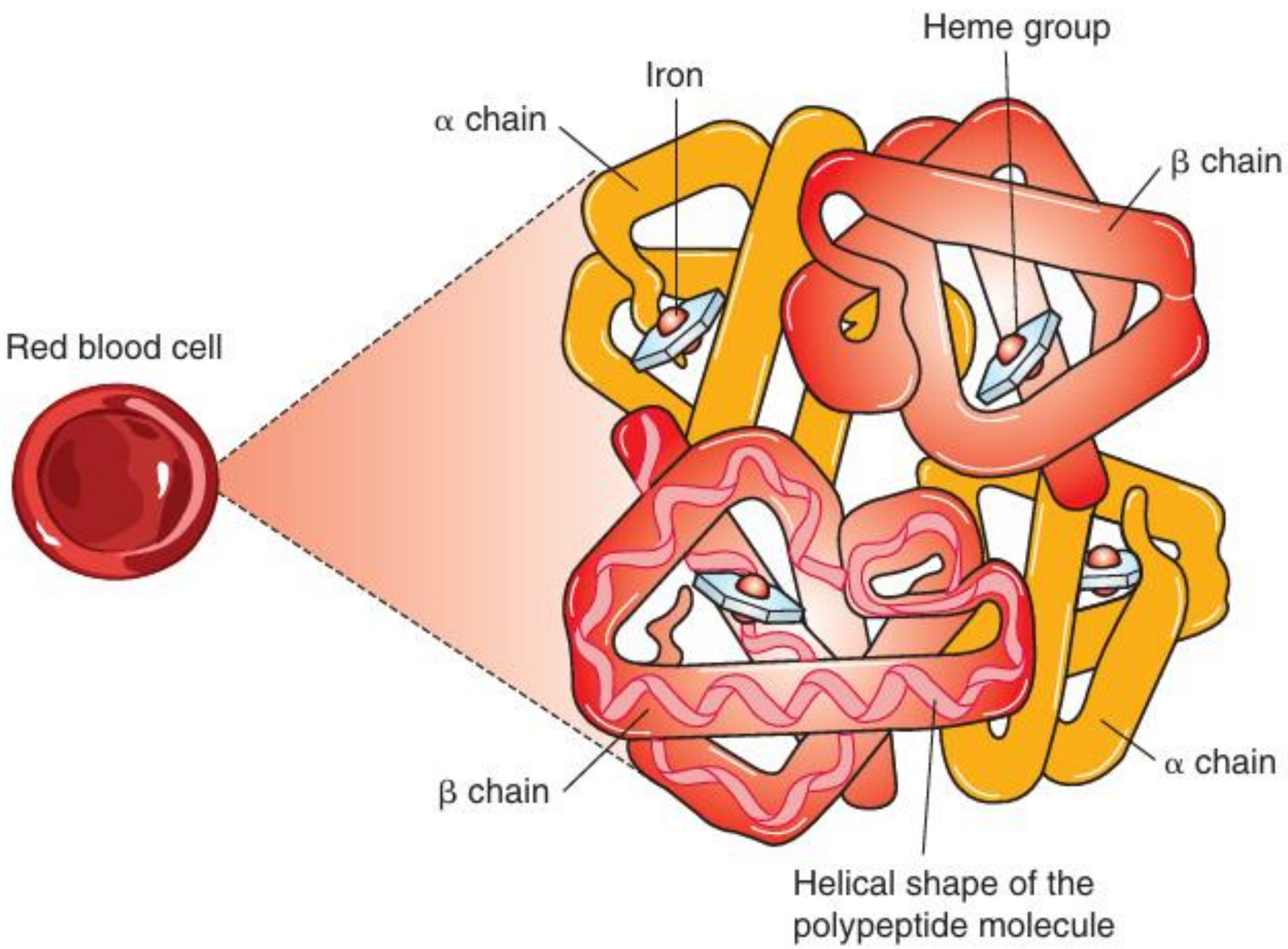
Physiology of Respiratory System



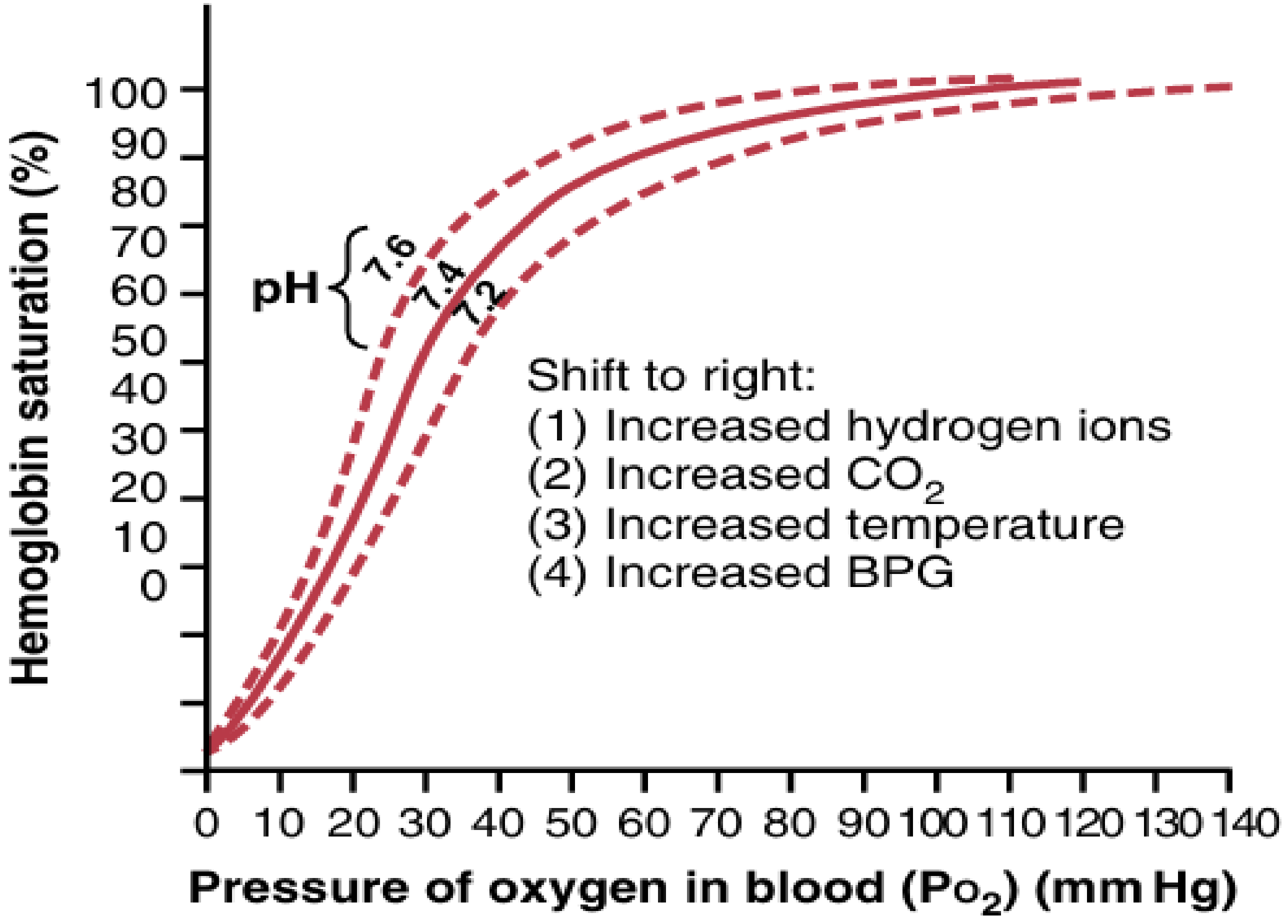
Physiology of Respiratory System



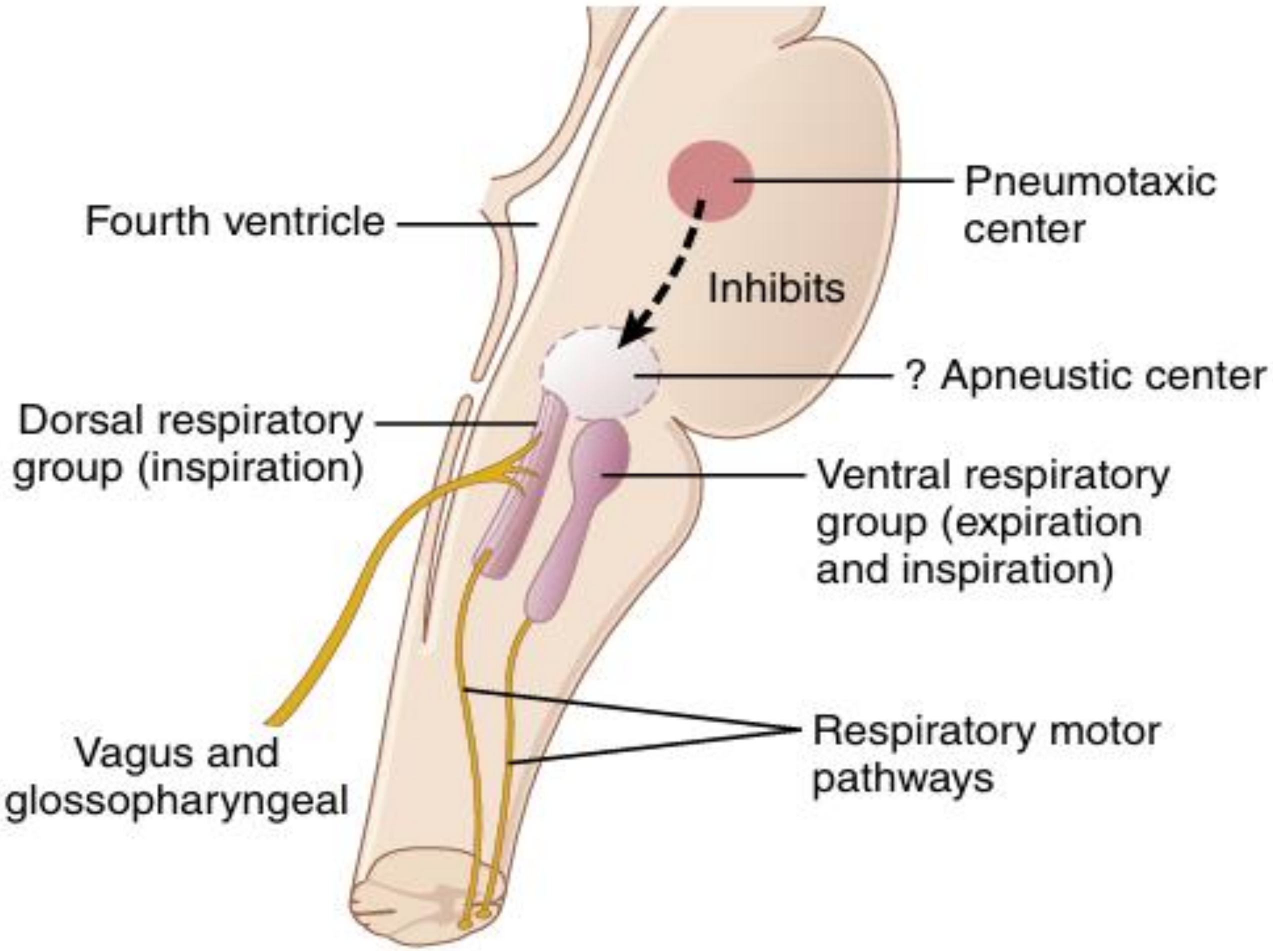
Physiology of Respiratory System



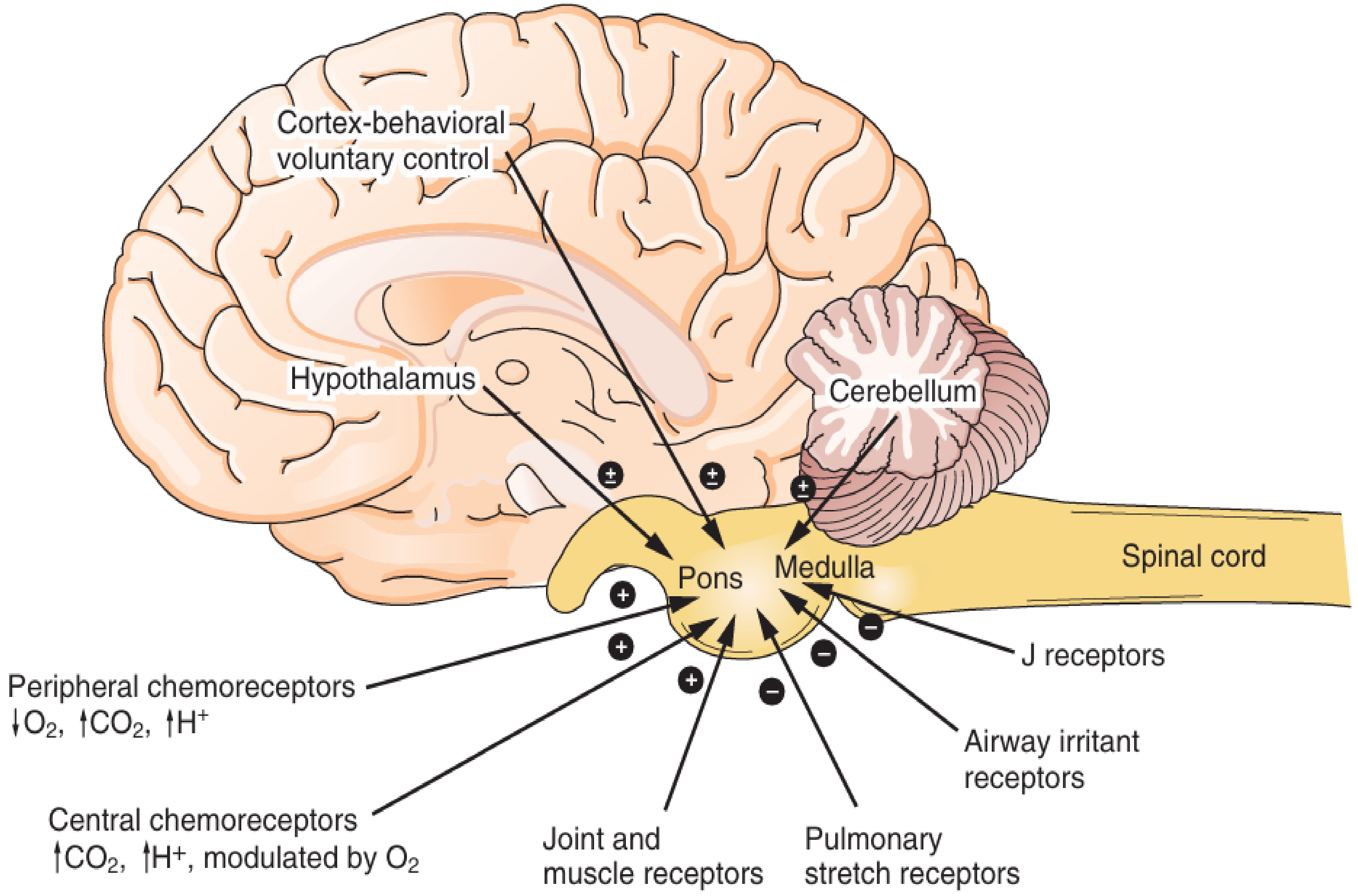
Physiology of Respiratory System



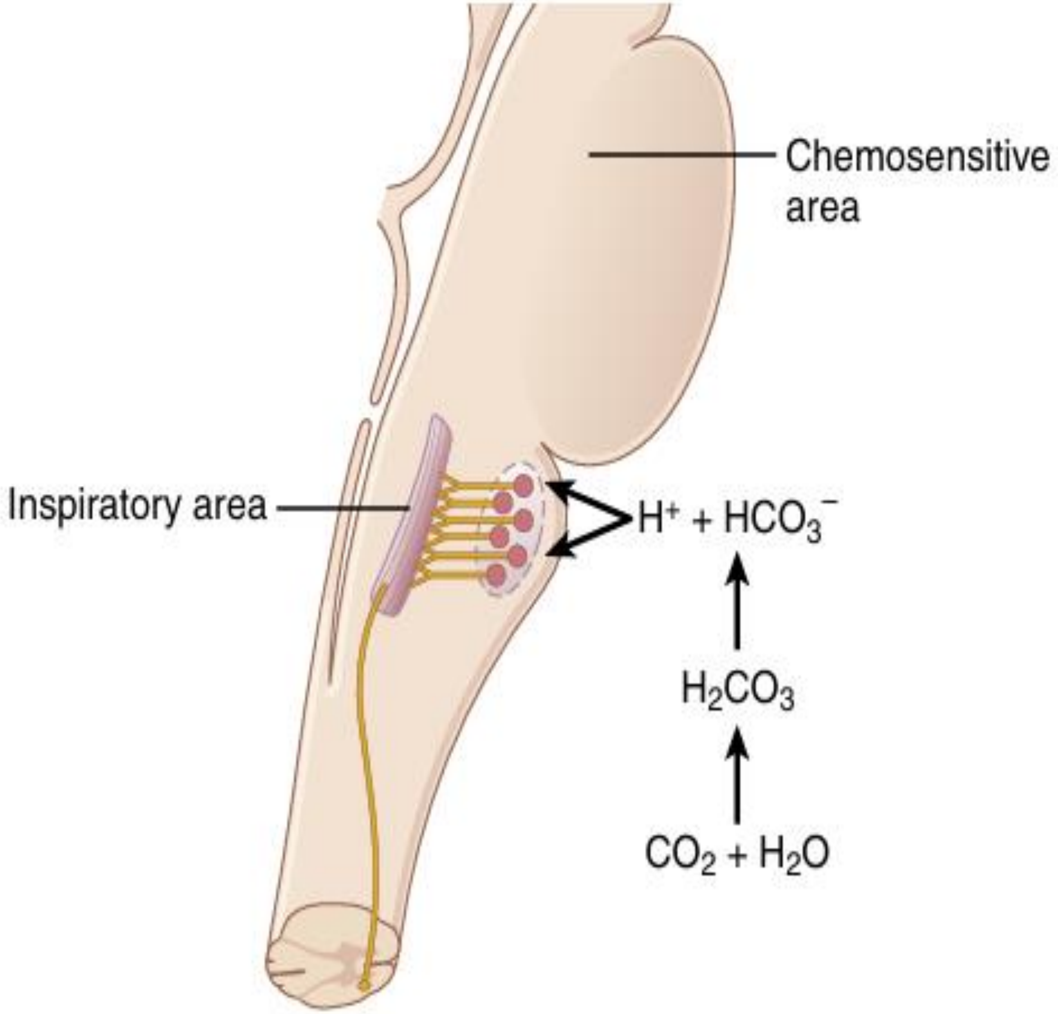
Physiology of Respiratory System



Physiology of Respiratory System



Physiology of Respiratory System



Physiology of Respiratory System